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IDENTIFIERS	DACUM Process

ABSTRACT

This package consists of course syllabi, an instructor's handbook, and a student laboratory manual for a 2-year vocational training program to prepare students for entry-level employment as instrumentation and control technicians. The program was developed through a modification of the DACUM (Developing a Curriculum) technique. The course syllabi volume begins with the MASTER (Machine Tool Advanced Skills Technology Educational Resources) Program Consortium competency profile with 8 duties (and supporting technical workplace competencies): practice safety; maintain control systems; maintain field instrumentation devices; organize work routines; collect and file data; participate in continuing education activities; maintain and control inventory; and troubleshoot, install, maintain, and operate motor control systems. The first volume contains the justification, documentation, and course syllabi for the courses. Each syllabus contains the following: course description; prerequisites; course objectives; required course materials; methods of instruction; lecture outline; lab outline; Secretary's Commission on Achieving Necessary Skills competencies taught; and appropriate reference materials. The two-volume instructor's handbook consists of technical training modules that include some or all of the following: time required; duty; task; objective(s); instructional materials list; references; student preparation; introduction; presentation outline; practical application; evaluation; summary; and attachments, including handouts, laboratory worksheets, and self-assessment with answer key. The handbook is arranged by duty grouping, with technical modules developed for each task box on the competency profile. The student laboratory manual contains a DACUM chart and learning modules. Each module in

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the student manual includes some or all of the following: objectives, outline, laboratory exercises, laboratory aids, and handouts. (YLB)

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ED 422 488

Instrumentation Series
Educational Resources for the Machine Tool Industry
Course Syllabi
Instructor's Handbook
Student Laboratory Manual

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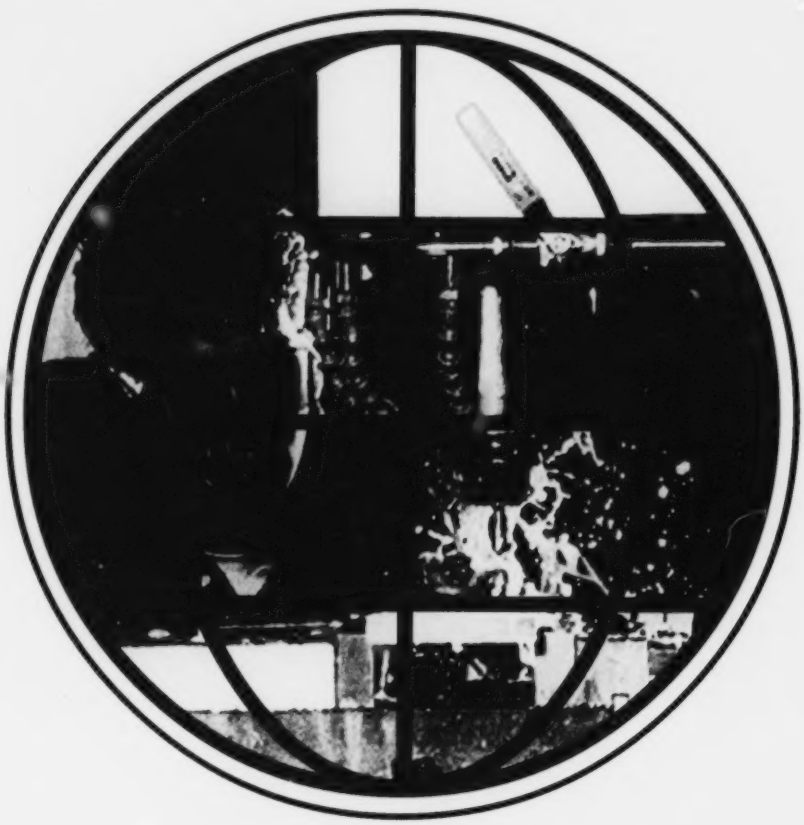
MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

a consortium of educators and industry

EDUCATIONAL RESOURCES FOR THE MACHINE TOOL INDUSTRY



Instrumentation Series

COURSE SYLLABI

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Supported by the National Science Foundation's Advanced Technological Education Program

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

EDUCATIONAL RESOURCES FOR THE MACHINE TOOL INDUSTRY

Instrumentation Series

COURSE SYLLABI

Supported by the National Science Foundation's Advanced Technological Education Program

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National Science Foundation
Advanced Technological Education Program

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National Science Foundation - Division of Undergraduate Education
MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS
Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES
AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES
Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS
Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.

Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

MASTER DEVELOPMENT CENTER, AUGUSTA, GA
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Manufacturing in the Augusta Region

Augusta is the second largest city in Georgia and manufacturing represents the largest sector of the Augusta economy. The region is home to 810 manufacturers employing 89,717 people, an industrial base consisting of about 75% process control and 25% discrete parts production facilities. Major areas of emphasis for industry include technology transfer, factory floor training, and job certification programs. Growth of manufacturing in the region has been driven by Augusta's high tech development in electronics, process control, telecommunications, computers, medical services and instrumentation.

Augusta Technical Institute and Center for Advanced Technology (CADTEC)

Augusta Technical Institute (ATI) is part of Georgia's Department of Technical and Adult Education system, serving a large percentage of the two-state Central Savannah River area through its main campus and satellite facilities. The student body includes vocational-technical and college prep students, as well as current workers seeking retraining or skills upgrade; ATI has long emphasized outreach and special attention to the needs of low income, rural and disadvantaged residents, as well as displaced workers, single parents, women in non-traditional fields, and the disabled. In 1983, the Institute used the opportunity to host one of Georgia's new regional advanced technology centers (ATC's) to streamline its technical programs and thereby help to ensure the future employability of its students. ATI's Center for Advanced Technology (CADTEC) is designed to provide technology research and demonstration, industry assessments, technical consulting, and industry-specific contract training for the many established and emerging high tech companies in the Augusta region.

Development Team

- **Project Director:** Mr. Ray Center, Director of CADTEC, served as program director for the MASTER project.
- **Subject Matter Expert**: Ronnie Lambert, MS, MASTER Site Coordinator, had program responsibility for developing skill standards based on the industry skills verification process, as well as developing course curricula and program materials for the MASTER pilot program in Industrial Maintenance Mechanic and Instrumentation Technician. Mr. Lambert has taught Industrial Maintenance Mechanic and Instrumentation for 32 years in colleges and industry across the Southeast.

Introduction

MASTER research indicates that individuals working as Instrumentation and Control Technicians will preferably have received at least two years of training and education in both academic and technical courses in the areas of instrumentation and control methods and processes. This training may have been conducted in a vocational institution or college. Our research indicates that a minimum of two years of vocational training will prepare students with entry level skills necessary to begin work as an Instrumentation and Control Technician.

In this two-year program, the students progress through a series of courses designed to both educate and train students with knowledge and skills in areas such as data acquisition and control of systems with use of electronics and digital computers, dynamic evaluation, testing, controller tuning, and total system performance. Students receive a wide range of training which enables them to seek jobs in many different areas. The Instrumentation Program at Augusta Technical Institute (ATI) has been training Instrumentation and Control Technicians for many years and works closely with advisory committee members to make sure that the skills being taught are the skills needed in industry. Students who graduate from this course of study receive Associate of Applied Science degrees from ATI. The Instrumentation Department worked closely with the MASTER staff, made every effort to assist the MASTER staff with research, and currently seek adoption of the recommended MASTER materials for their Instrumentation students. The Instrumentation Department at ATI is recognized throughout Georgia by large and small manufacturing companies as a premier source for entry-level technicians. Upon graduation, students are able to work in field technical sales, field service representation, instrumentation engineering, network systems, computer systems technology, and even some robotics interfacing. The curriculum has been designed to prepare students to enter the workforce as entry-level Instrumentation and Control Technicians. Laboratory work is emphasized with actual industrial equipment in order to prepare students for interesting, rewarding work in a wide variety of industries such as oil, chemical, petro chemical, power, big manufacturing plants, water utilities, and even large municipalities with large power plants. The Instrumentation department has a unique blend of theoretical knowledge and practical application which directly corresponds to modern uses in instrumentation.

After many interviews with practitioners from industry and discussions with educators, managers, supervisors, and others involved with machine-related occupations (specifically instrumentation and control), the MASTER Consortium Partners have agreed to present our definition of an instrumentation and control technician as follows:

INSTRUMENTATION AND CONTROL TECHNICIAN - troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluation.

This volume contains the justification, documentation, and course syllabi for the courses which we recommend as minimum training for individuals desiring to become instrumentation and control technicians.

The first and most important task of the **MASTER** program was the development of a foundation upon which all other works could be built. The **MASTER** Competency Profile is this foundation.

The MASTER Competency Profile

Development of Competency Profiles at each of the MASTER sites began with visits to representative companies for the purpose of surveying expert workers within the industry and occupational areas under investigation. Each site began the survey process by asking a subject matter expert in the targeted technical area, generally a member of its faculty, to employ a modified version of the generally accepted DACUM (Developing A Curriculum) method to categorize the major skills needed to work in the selected occupation. As source materials, the college instructors drew on their professional knowledge and experience of current industry requirements and trends. The initial skill standards developed by the subject matter experts underwent numerous internal reviews and revisions within each site, assuming final form as a series of structured survey and interview questions designed to elicit a simple yes or no response.

To determine an appropriate survey sample, each site compiled a database of its region's small and medium-sized manufacturers and searched for companies likely to employ workers in the targeted occupational area. The resulting cross-industry samples were sorted further to achieve a balance of technological capability and workforce size; the sample companies within each region were then asked to participate in the project. Willing respondents were scheduled for interviews.

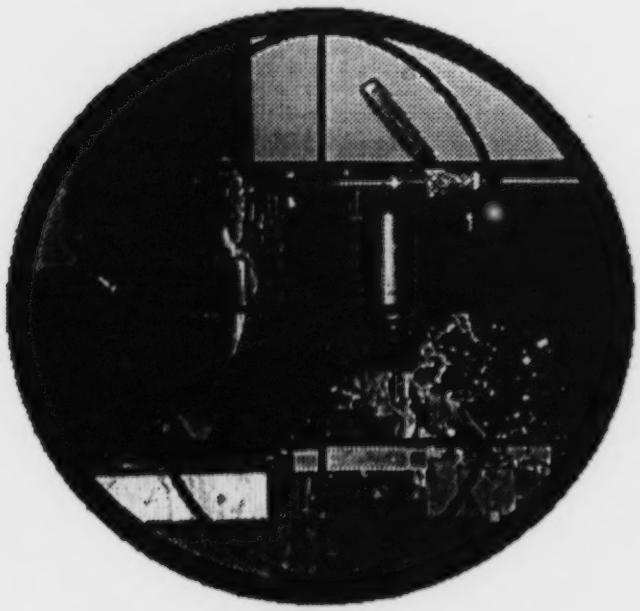
During the company interviews, the MASTER staff asked expert workers to identify the primary duties and tasks performed by a typical worker and to consider the special skills and knowledge, traits and attitudes, and industry trends that would have an impact on worker training, employability, and performance both now and in the future. The interview results were analyzed to create individual profiles identifying the most common duties and skills required of workers at each company. These individual company Competency Profiles served two purposes. First, they showed, in a format that could be easily understood by both industries and educators, a picture of the occupational specialty at a given company at that particular time. Second, these individual company Competency Profiles furnished the company with a document over which they could claim ownership. This, in effect, made them real partners in the work of MASTER.

Data for all companies were then aggregated to develop a composite Competency Profile of industry skill standards within the selected occupational specialty area of Instrumentation, as shown on the following page.

These same duties and tasks were then included in both the Texas and National Surveys for further validation. As a result of the surveys, additional refinements were made in the Competency Profiles. These changes were incorporated into the individual course syllabi which were used for the pilot program.

The MASTER Competency Profile for Instrumentation and Control Technician has been included on the following page.

Instrumentation and Control Technician Competency Profile



Job Analysis conducted and prepared by

MASTER

***M*achine Tool *A*dvanced *S*kills *T*echnology *E*ducational *R*esources Program Consortium

INSTRUMENTATION AND CONTROL TECHNICIAN

Technical Workplace Competencies

Duties	Tasks			
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety
	A-5 Lifting safety	A-6 Lockout/tagout	A-7 Use electrical equipment	
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices
	B-5 Test and/or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Troubleshoot different types of system modules	B-8 Test different types of systems modules
	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check
	B-13 Loop check control system	B-14 Perform on-line testing		
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Troubleshoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Troubleshoot control drive (damper)
	C-5 Test and calibrate indicators and gauges	C-6 Troubleshoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders
	C-9 Troubleshoot and repair recorders	C-10 Troubleshoot linear variable differential transformers	C-11 Troubleshoot and repair transmitters	C-12 Test different field sensing elements, flow, temperature, pressure, and level

INSTRUMENTATION AND CONTROL TECHNICIAN

Technical Workplace Competencies

Duties	Tasks			
C Maintain Field Instrumentation Devices (continued)	C-13 Install/replace field sensing elements	C-14 Calibrate transmitters	C-15 Tune controllers: pneumatic and electronic	C-16 Troubleshoot and repair plant computing systems relating to process controls
	C-17 Troubleshoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements
	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Troubleshoot and repair control valves and positioners	C-24 Test and calibrate controllers
	C-25 Troubleshoot and repair local controllers	C-26 Troubleshoot and repair electronic computing relays	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers
	C-29 Test and calibrate water analyzers	C-30 Troubleshoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit
	C-33 Check and adjust video display unit	C-34 Design, specify and configure smart field devices, i.e., transmitters and valves	C-35 Operate control systems including single element, cascade, ratio, and feedforeward	C-36 Troubleshoot and repair analyzers
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Determine proper tools, equipment, and materials to perform the job	D-3 Coordinate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group
	D-5 Verify equipment isolation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibration procedures if needed	D-8 Follow specifications and procedures
	D-9 Perform basic algebraic operations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations	

INSTRUMENTATION AND CONTROL TECHNICIAN

Technical Workplace Competencies

Duties	Tasks			
E Collect and File Data	E-1 Record test/ calibration data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data
	E-5 Review/revise procedures if needed	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specification forms
	E-9 Write work orders			
F Participate in Continuing Education Activities	F-1 Read/interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Application of ISA/JIC standards
	F-5 Understand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals
	F-9 Understand personal computers	F-10 Attend on-going safety training courses	F-11 Participate in plant related training	F-12 Attend PLC training
	F-13 Attend DCS training			
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/verify substitute specifications
H Troubleshoot, Install, Maintain, and Operate Motor Control Systems	H-1 Troubleshoot, install, maintain, and operate motor starters	H-2 Troubleshoot, install, maintain, and operate relays	H-3 Troubleshoot, install, maintain, and operate pushbuttons	H-4 Troubleshoot, install, maintain, and operate switches

INSTRUMENTATION AND CONTROL TECHNICIAN

Technical Workplace Competencies

Duties	Tasks			
H **Troubleshoot, Install, Maintain, and Operate Motor Control Systems (continued)**	H-5 Troubleshoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Troubleshoot, install, maintain and operate PLCs

Instrumentation and Control Technician

Skills, Traits and Trends

Skills and Knowledge

Ability to Comprehend Written/Oral Instructions
Ability to Work as Part of a Team
Communication Skills
Converse in the Technical Language of the Trade
Knowledge of Calibration Procedures
Knowledge of Company Policies/ Procedures
Knowledge of Company Quality Assurance Activities
Knowledge of Employee/Employer Responsibilities
Knowledge of Occupational Opportunities
Knowledge of Safety Regulations
Mathematical Skills - Algebra and Trigonometry
Mechanical Aptitude
Organizational Skills
Practice Quality-Consciousness in Performance of the Job
Practice Safety in the Workplace
Reading/Writing Skills
Use Inspection Devices
Use Pneumatic and Electronic Measurement Devices

Traits and Attitudes

Customer Relations
Dependability
Honesty
Interpersonal Skills
Neatness
Personal Ethics
Physical Ability
Professional
Punctuality
Responsible
Safety Consciousness
Self Motivation
Strong Work Ethic
Trustworthy

Tool/Equipment Proficiency

AC Solid State Drives
Air Analyzers
Calibrated Instruments (VOM, Pressure Supply)
Computer
Control Valves/Positioners
Controllers
P/I, I/P, Single Loop, Multiloop
Dampers
DC Solid State Drives
Digital Training Equipment
Electrical Training Equipment
Gas Analyzers
Gauges (Pressure, Limit, Flow)
Hand Tools
Ice Bath
Instrument Lab
Instrumentation Tech's Tools (Lab Calibrated against standard)
Instrumentation Training Equipment
Linear Variable Differential Transformer
Mass Flowmeters
Personal Safety Equipment
pH Analyzer
Programmable Controllers
Recorders/Indicators
Safety Training Equipment
Spectrometer
Strain Gauges
Transducers
Transmitters
Water Analyzers

Current Trends

Advanced Computer Applications
Automated Material Handling Equipment
Computer Integrated Manufacturing
Distributed Control Systems
Environmental Concerns
Fiber Optic Controls
Robotics
Statistical Process Control

The MASTER Pilot Program
Curriculum and Course Descriptions

After completing the Competency Profile for each occupational specialty area, each MASTER partner reviewed its existing curriculum against the industry–verified skill standards in order to identify a suitable foundation for new pilot training programs. Because each college had to comply with the requirements of its respective college system and appropriate state agency, the resulting pilot curricula for occupational specialty areas tended to vary in format and academic requirements (e.g., some programs were based on the semester system, others on the quarter system). Despite differences in the curricula developed at the partner colleges, each of the pilot programs was designed to achieve the following two goals mandated in the MASTER grant proposal:

> ***Pilot Program***: "Conduct a one year pilot program with 25 or more selected applicants at each college or advanced technology center to evaluate laboratory content and effectiveness, as measured by demonstrated competencies and indicators of each program area."
>
> ***Student Assessment***: "Identify global skills competencies of program applicants both at point of entrance and point of exit for entry–level and already–employed technicians."
>
> (***Note***: Not all occupational specialty areas were pilot–tested at all Development Centers; however, all partner colleges conducted one or more pilot programs.)

Included on the following page is the curriculum listing for the pilot program which was used to validate course syllabi for this occupational specialty area. The curriculum also shows the number of hours assigned to each of the courses (lecture, laboratory and credit hours). Also included is a description of each of the courses.

MASTER Curriculum
INSTRUMENTATION
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
FIRST QUARTER*				
MATH 191	College Algebra	5	0	5
ENGL 191	Composition and Rhetoric I	5	0	5
CIS 191	Computer Programming Fundamentals	3	6	5
DDF 191	Engineering Graphics I	1	6	3
		14	12	18
SECOND QUARTER*				
MATH 193	College Trigonometry	5	0	5
ENGL 195	Technical Communications	5	0	5
PHY 191	Mechanics	4	3	5
INT 101	DC Circuit Analysis	4	3	5
		18	6	20
THIRD QUARTER*				
MATH 195	Differential Calculus	5	0	5
PHY 192	Electricity and Magnetism	4	3	5
INT 102	AC Circuit Analysis I	4	3	5
INT 105	Electronic Devices	4	3	5
		17	9	20
FOURTH QUARTER*				
PHY 291	Fluids, Heat, Sound and Light	4	3	5
INT 103	AC Circuit Analysis II	4	3	5
INT 201	Digital Fundamentals	4	3	5
EMT 201	Electromechanical Devices	4	3	5
		16	12	20
FIFTH QUARTER*				
EMT 202	Control Systems	4	3	5
INT 203	Microcomputer Fundamentals	4	3	5
EMT 203	Programmable Controllers	3	3	4
EMT 253	Motor Controls	4	3	5
		15	12	19

SIXTH QUARTER*

EMT 254	Introduction to Process Control (Technical Elective)	2	6	4
EMT 250	Control Systems II (Technical Elective)	4	3	5
EMT 251	Distributed Control Systems (Technical Elective)	3	3	4
PSY 191	Introductory Psychology (Social Science Elective)	5	0	5
		14	12	18
	Program Totals	94	63	115

***Each quarter is 10 weeks in length.**

MASTER Course Descriptions
Instrumentation
(Associate of Applied Science Degree Program)

First Quarter

MATH 191 **College Algebra** (3-0-5) Emphasizes techniques of problem solving using algebraic concepts. Topics include: algebraic concepts and operations, linear and quadratic equations and functions, simultaneous equations, inequalities, exponents and powers, graphing techniques, and analytic geometry. Prerequisite: Placement by diagnostic testing.

ENGL 191 **Composition and Rhetoric I** (5-0-5) Explores the analysis of literature and articles about issues in the humanities and in society. Students practice various modes of writing, ranging from exposition to argumentation and persuasion. The course includes a review of standard grammatical and stylistic usage in proofreading and editing. An introduction to library resources lays the foundation for research. Topics include writing analysis and practice, revision, and research.

CIS 191 **Computer Programming Fundamentals** (3-6-5) Emphasizes fundamental concepts of problem solving using computers. Students explore flow charting, control structures, subroutines, arrays, strings manipulation, matrices, and files. A high level source language is used. The laboratory portion of the course is designed to acquaint students with computer facilities and software utilities. Topics include: system fundamentals, concepts of structured programming, arrays, functions and subroutines, data files, engineering applications, graphics, matrices, and program editing. Laboratory work parallels class work.

DDF 191 **Engineering Graphics I** (1-6-3) Introduces engineering drawing. Topics include: sketching, drafting fundamentals such as use of instruments, linework, lettering, layout, and geometric construction; orthographic projection; pictorial drawing; schematic drawing; descriptive geometry; computer graphics concepts; and engineering drawing conventions. Laboratory work parallels class work.

Second Quarter

MATH 193 **College Trigonometry** (5-0-5) Emphasizes techniques of problem solving using trigonometric concepts. Topics include: trigonometric functions, properties of trigonometric functions, vectors and triangles, inverse of trigonometric functions/graphic, logarithmic and exponential functions, and complex numbers. Prerequisite: MATH 191, College Algebra

ENGL 195 **Technical Communications** (5-0-5) Emphasizes practical knowledge of technical communications techniques, procedures, and reporting formats used in industry and business. Topics include: research, device and process description, formal technical report writing, business correspondence, and oral technical report presentation. Prerequisite: ENGL 191, Composition and Rhetoric.

PHY 191 **Mechanics** (4-3-5) Introduces the classical theories of mechanics. Topics include: measurements and systems of units; Newton's laws; work, energy, and power; impulse and momentum; linear motion and two-dimensional motion; equilibrium; and elasticity. Laboratory exercises supplement class work. Computer use is an integral part of class and laboratory assignments. Prerequisites: MATH 191, College Algebra, and CIS 191, Computer Programming Fundamentals

INT 101 **DC Circuit Analysis** (4-3-5) Emphasizes the knowledge and ability to analyze basic DC circuits. Topics include: units, basic electrical laws, series and parallel circuits, capacitance, an introduction to network analysis and network theorems concepts, and DC instruments. Laboratory work parallels class work. Prerequisites: CIS 191, Computer Programming Fundamentals, and MATH 191, College Algebra

Third Quarter

MATH 195 **Differential Calculus** (5-0-5) Emphasizes the use of differential calculus. Applications of techniques include extreme value problems, motion, graphing, and other topics as time allows. Topics include: derivatives and applications, differentiation of transcendental functions, and an introduction to integration and applications. Prerequisite: MATH 193, College Trigonometry

PHY 192 **Electricity and Magnetism** (4-3-5) Introduces theories of electricity and magnetism. Topics include: electrostatic forces and fields, magnetism, circuit elements and theory, electromagnetic waves, and modern physics. Laboratory exercises supplement class work. Computer use is an integral part of class and laboratory assignments. Prerequisites: MATH 193, College Trigonometry, and PHY 191, Mechanics.

INT 102 **AC Circuit Analysis I** (4-3-5) Emphasizes the knowledge and ability to analyze basic AC circuits. Topics include: magnetism, inductance/capacitance, alternating current, AC network theorems, admittance, impedance, phasors, complex power, and applications and use of appropriate instruments. Laboratory work parallels class work. Prerequisites: INT 101, DC Circuit Analysis, and MATH 193, College Trigonometry.

INT 105 **Electronic Devices** (4-3-5) Introduces the conduction process in semi-conductor materials. Topics include: semi–conductor physics; diodes; biasing, stability, and graphical analysis of bipolar junction transistors and field effect transistors; introduction to silicon controlled rectifiers; device curve characteristics; and related devices with selected applications. Laboratory work parallels class work. Prerequisites: INT 101, DC Circuit Analysis, ENGL 191, Composition and Rhetoric I, and MATH 193, College Trigonometry.

Fourth Quarter

PHY 291 **Fluids, Heat, Sound, and Light** (4-3-5) Introduces classical theories of fluids, heat, sound, and light. Topics include: statics and dynamics of fluids, gas laws, heat transfer, thermodynamics, simple harmonic motion, wave motion, sound, and properties of light. Laboratory exercises supplement class work. Computer use is an integral part of class and laboratory assignments. Prerequisites: MATH 193, College Trigonometry, and PHY 191, Mechanics.

INT 103 **AC Circuit Analysis II** (4-3-5) Continues the study of AC circuit analysis with emphasis on transient analysis and network theorems. Topics include: analysis of complex networks, resonance, transformers, multiple sources, three–phase systems, an introduction to filters and bode plots, and non–sinusoidal waveforms. Laboratory work parallels class work. Prerequisites: INT 102, AC Circuit Analysis I, and MATH 195, Differential Calculus.

INT 201 **Digital Fundamentals** (4-3-5) Introduces digital electronics. Topics include: fundamentals of digital techniques; integrated logic circuits involving number systems, logic symbols and gates, Boolean algebra, and optimization techniques; flip–flops and registers; combinational and sequential logic circuits; and memory circuits. Laboratory work parallels class work. Prerequisite: INT 102, AC Circuit Analysis I.

EMT 201 **Electromechanical Devices** (4-3-5) Introduces electromechanical devices which are essential control elements in electrical systems. Topics include: fundamentals of electromechanical devices, control elements in electrical circuits, typical devices such as generators and alternators, DC and AC motors and power factors, and efficiencies in DC, single–phase and three–phase dynamos are stressed. Laboratory work parallels class work. Prerequisite: INT 102, AC Circuit Analysis I.

Fifth Quarter

EMT 202 **Control Systems** (4-3-5) Introduces control systems components and theory as they relate to controlling industrial processes. Mechanical, fluids, temperatures, and miscellaneous sensors are studied with emphasis on measuring techniques. Topics include: open– and closed–loop control theory, feedback, transducers, signal conditioning, and control hardware and actuators. Laboratory work parallels class work. Prerequisite: INT 201, Digital Fundamentals.

INT 203 **Microcomputer Fundamentals** (4-3-5) Continues the study of digital electronics. Topics include: computer arithmetic, analog to digital and digital to analog conversion, microcomputer architecture, and machine level and assembly level language programming. Laboratory work parallels class work. Prerequisites: INT 105, Electronic Devices, and INT 201, Digital Fundamentals.

EMT 203 **Programmable Controllers** (3-3-4) Emphasizes an in–depth study of the programmable controller with programming applications involving controlling industrial processes. Topics include: input and output modules, logic units, memory units, power supplies, ladder diagrams, relay logic timers and counters, control strategy, programming and troubleshooting. Networking is introduced and communications protocol is investigated. Lab work parallels class work. Prerequisites: INT 201, Digital Fundamentals; Corequisite: EMT 201, Electromechanical Devices.

EMT 253 **Motor Controls** (4-3-5) Emphasizes the principles of motor controls from fractional horsepower to large magnetic starters, including starting polyphase induction, synchronous, wound rotor, and direct current motors. Topics include: control pilot devices, control circuits and AC reduced voltage starters, three–phase induction, wound rotor, and synchronous motor controls, DC motors, and solid state motor controls. Prerequisite: EMT 201, Electromechanical Devices.

Sixth Quarter

EMT 254 **Introduction to Process Control** (2-6-4) Emphasizes the knowledge and skills required to draw and interpret standard ISA drawings. Topics include: instrumentation symbols, loop identification, open–loop control, closed–loop control, single–loop control and multi–loop control. Prerequisite: DDF 191, Engineering Graphics I; Corequisite: PHY 291, Fluids, Heat, Sound, and Light.

EMT 250 **Control Systems II** (4-3-5) Emphasizes skills in the area of electronic instrumentation and stresses the use of electronic

techniques to control industrial processes. Topics include: control systems, control system design, control system construction, and control system test report of failure analysis. Prerequisite: EMT 202, Control Systems.

EMT 251 **Distributed Control Systems** (3-3-4) Continues the study of the various applications of distributed control. This course in intended primarily as a survey source of distributed control verses an in-depth study of any single distributed control system. Topics include: historical perspective and systems, basic system wide orientation, sub systems overview, and report generation. Prerequisite: EMT 202, Control Systems.

PSY 191 **Introductory Psychology** (5-0-5) Emphasizes the basics of psychology. Topics include: science of psychology; social environments; life stages; physiology and behavior; personality; emotions and motives; conflicts, stress and anxiety; abnormal behavior; and perception, learning, and intelligence.

The MASTER
Technical Workplace Competencies
and
Course Crosswalk

After development of appropriate curricula for the pilot programs, each MASTER college began to develop individual course outlines for its assigned specialty area. The skill standards identified in the Competency Profile were cross walked against the technical competencies of the courses in the pilot curriculum. The resulting matrix provided a valuable tool for assessing whether current course content was sufficient or needed to be modified to ensure mastery of entry-level technical competencies. Exit proficiency levels for each of the technical competencies were further validated through industry wide surveys both in Texas and across the nation.

The Technical Workplace Competencies and Course Crosswalk on the following pages presents the match between industry—identified duties and tasks and the pilot curriculum for Instrumentation. Course titles are shown in columns; duties and tasks, in rows. The Exit Proficiency Level Scale (see Figure 1), an ascending scale with 5 as the highest level of proficiency, includes marked boxes indicating whether the task is covered by the instructor during the course; the numbers 1–5 indicate the degree of attention given to the task and the corresponding proficiency expected on the part of the student upon completion of the course of studies. The crosswalk is intended to serve as an aide to other instructional designers and faculty in community college programs across the nation.

EXIT PROFICIENCY LEVEL SCALE					
Technical Workplace Competency	**1**	**2**	**3**	**4**	**5**
	Rarely	Routinely with Supervision	Routinely with Limited Supervision	Routinely Without Supervision	Initiates/ Improves/ Modifies and Supervises Others

Figure 1

Included on the following pages is the Technical Workplace Competencies and Course Crosswalk for the pilot program curriculum. This crosswalk validates the fact that the duties and tasks which were identified by industry as being necessary for entry–level employees have been incorporated into the development of the course syllabi.

INSTRUMENTATION AND CONTROL TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Computer Prog. Fundamentals	Engineering Graphics I	Mechanics	DC Circuit Analysis	Electricity and Magnetism	AC Circuit Analysis I	Electronic Devices	Fluids, Heat, Sound, and Light	AC Circuit Analysis II	Digital Fundamentals	Electromechanical Devices	Control Systems	Microcomputer Fundamentals	Programmable Controllers	Motor Controls	Introduction to Process Control	Control Systems II	Distributed Control Systems			EXIT PROFICIENCY LEVEL
A. PRACTICE SAFETY																					
A-1 Use Protective Equipment			I	R	R	R	R	R	R	R	R	R	R	R	R	R	R	M			4
A-2 Accident Prevention			I	R	R	R	R	R	R	R	R	R	R	R	R	R	R	M			4
A-3 Working Aloft			I	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R			3
A-4 Fire Safety			I	R	R	R	R	R	R	R	R	R	R	R	R	R	R	M			4
A-5 Lifting Safety			I	R	R	R	R	R	R	R	R	R	R	R	R	R	R	M			4
A-6 Lockout/Tagout			I	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R			3
A-7 Use Electrical Equipment			I	R	R	R	R	R	R	R	R	R	R	R	R	R	R	R			3
B. MAINTAIN CONTROL SYSTEMS																					
B-1 Proper Storage of Circuit Boards	I				R	R	R	R		R	R	R		R	R	R	R	R			2
B-2 Collect and Record Data According to Company Requirements		I		R	R		R	R	R	R	R	R		R	R	R	R	M			4
B-3 Test and Calibrate Transducers According to Specs					I	R	R	R		R	R	R		R	R	R	R	R			3
B-4 Perform Preventive Maintenance Procedures for Control Devices				I	R		R	R	R	R	R	R		R	R	R	R	R			3
B-5 Test and/or Replace Printed Circuit Boards					I		R	R		R	R	R		R	R	R	M	R			4
B-6 Function Check Individual Elements Within Loop					I		R	R	R	R	R	R		R	R	R	R	M			4
B-7 Troubleshoot Different Types of System Modules					I		R	R	R	R	R	R		R	R	R	R	R			3
B-8 Test Different Types of Systems Modules					I	R	R	R	R	R	R	R		R	R	R	R	R			3
B-9 Configure Software	I				R	R	R	R	R	R	R	R	R	R	R	R	R	R			2
B-10 Repair Different Types of System Modules					I			R			R	R		R	R	R	R	R			3
B-11 Install Control System Hardware			I		R			R	R		R	R		R	R	R	M	R			4
B-12 Simulate Control System Check				I	R	R		R	R		R	R		R	R	R	R	R			3
B-13 Loop Check Control System		I			R			R			R	R		R	R	R	R	M			4
B-14 Perform On-Line Testing	I			R	R	R		R	R		R	R		R	R	R	R	R			3
C. MAINTAIN FIELD INSTRUMENTATION DEVICES																					
C-1 Test and Calibrate Pressure, Level, Flow, and Temperature Switches					I			R			R	R		R	R	R	R	M			4
C-2 Troubleshoot and Repair Pressure, Level, Flow, and Temperature Switches					I			R			R	R		R	R	R	R	M			4
C-3 Adjust Dampers and Positioners					I						R	R		R	R	R	R	M			4
C-4 Troubleshoot Control Drive (Damper)					I						R	R		R	R	R	R	M			4

I=Introduced and Taught R=Repeated and Reinforced M=Mastered

INSTRUMENTATION AND CONTROL TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Computer Prog. Fundamentals	Engineering Graphics I	Mechanics	DC Circuit Analysis	Electricity and Magnetism	AC Circuit Analysis I	Electronic Devices	Fluids, Heat, Sound, and Light	AC Circuit Analysis II	Digital Fundamentals	Electromechanical Devices	Control Systems	Microcomputer Fundamentals	Programmable Controllers	Motor Controls	Introduction to Process Control	Control Systems II	Distributed Control Systems			EXIT PROFICIENCY LEVEL
C-5 Test and Calibrate Indicators and Gauges					I			R			R	R		R	R	R	R	M			4
C-6 Troubleshoot and Repair Indicators					I			R			R	R		R	R	R	R	M			4
C-7 Test Transmitters					I			R			R	R		R	R	R	R	M			4
C-8 Test and Calibrate Recorders					I						R	R		R	R	R	R	R			4
C-9 Troubleshoot and Repair Recorders					I						R	R		R	R	R	R	R			3
C-10 Troubleshoot Linear Variable Differential Transformers					I						R	R		R	R	R	R	R			3
C-11 Troubleshoot and Repair Transmitters					I						R	R		R	R	R	R	R			3
C-12 Test Different Field Sensing Elements, Flow, Temperature, Pressure, and Level					I			R			R	R		R	R	R	R	R			3
C-13 Install/Replace Field Sensing Elements				I	R						R	R		R	R	R	R	R			3
C-14 Calibrate Transmitters					I						R	R		R	R	R	R	R			3
C-15 Tune Controllers: Pneumatic and Electronic					I						R	R		R	R	R	R	R			3
C-16 Troubleshoot and Repair Plant Computing Systems Relating to Process Controls					I						R	R		R	R	R	R	R			3
C-17 Troubleshoot and Replace Solenoid Valves					I						R	R		R	R	R	R	R			3
C-18 Perform Preventive Maintenance Procedures For Field Devices					I						R	R		R	R	R	R	M			4
C-19 Test and Replace Thermocouples					I						R	R		R	R	R	R	R			3
C-20 Check and Test Vibration Sensing Elements					I						R	R		R	R	R	R	R			3
C-21 Inspect and Troubleshoot Power Supplies and Converters					I			R			R	R		R	R	R	R	R			3
C-22 Test and Calibrate Control Valve Actuators					I						R	R		R	R	R	R	R			3
C-23 Troubleshoot and Repair Control Valves and Positioners					I						R	R		R	R	R	R	R			3
C-24 Test and Calibrate Controllers											I	R		R	R	R	R	R			3
C-25 Troubleshoot and Repair Local Controllers											I	R		R	R	R	R	R			3
C-26 Troubleshoot and Repair Electronic Computing Relays										I	R	R		R	R	R	R	M			4
C-27 Test and Calibrate Gas Analyzers											I	R		R	R	R	R	R			3
C-28 Test and Calibrate Air Analyzers											I	R		R	R	R	R	R			3
C-29 Test and Calibrate Water Analyzers											I	R		R	R	R	R	R			3
C-30 Troubleshoot Servo Valves											I	R		R	R	R	R	R			3
C-31 Calibrate Servo Valves											I	R		R	R	R	R	R			3
C-32 Test and Clean Video Display Unit							I			R	R	R		R	R	R	R	R			2
C-33 Check and Adjust Video Display Unit							I			R	R	R		R	R	R	R	R			3
C-34 Design, Specify and Configure Smart Field Devices, i.e., Transmitters and Valves											I	R		R	R	R	R	R			3

INSTRUMENTATION AND CONTROL TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

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C-35 Operate Control Systems Including Single Element, Cascade, Ratio, and Feedforward											I	R		R	R	R	R	R			3
C-36 Troubleshoot and Repair Analyzers											I	R		R	R	R	R	R			3
D. ORGANIZE WORK ROUTINES																					
D-1 Organize Documents and Drawings Required on the Job												I			R	R	R	M			4
D-2 Determine Proper Tools, Equipment, and Materials to Perform the Job					I			R			R	R				R	R	M			4
D-3 Coordinate Work Activities With Other Crafts or Units					I						R	R				R	R	M			4
D-4 Coordinate Preventive Maintenance Schedule with Planning Group					I							R				R	R	R			2
D-5 Verify Equipment Isolation Prior to Performance of Work for Safety Reasons					I			R				R				R	R	M			4
D-6 Report Abnormal Equipment Problems to Supervisor					I							R				R	R	R			2
D-7 Write New Calibration Procedures if Needed					I							R				R	R	R			1
D-8 Follow Specifications and Procedures					I							R				R	R	M			4
D-9 Perform Basic Algebraic Operations					I							R				R	R	R			3
D-10 Perform Basic Trigonometric Functions					I							R				R	R	R			3
D-11 Perform Basic Calculus Operations					I							R				R	R	R			3
E. COLLECT AND FILE DATA																					
E-1 Record Test/Calibration Data					I			R								R	R	M			4
E-2 Record Preventive Maintenance Data					I											R	R	R			3
E-3 Record Equipment Disconnect Data					I											R	R	M			4
E-4 Evaluate Collected Data					I			R								R	R	R			2
E-5 Review/Revise Procedures if Needed					I											R	R	R			2
E-6 Write Reports Required by Company					I											R	R	M			4
E-7 Specify Equipment for Control Systems					I											R	R	R			2
E-8 Prepare and Update Specification Forms					I											R		R			2
E-9 Write Work Orders																I		R			2
F. PARTICIPATE IN CONTINUING EDUCATION ACTIVITIES																					
F-1 Read/Interpret Diagrams and Drawings					I						R	R		R	R	R	R	R			3
F-2 Sketch Diagrams					I						R	R		R	R	R	R	R			3

I=Introduced and Taught R=Repeated and Reinforced M=Mastered

INSTRUMENTATION AND CONTROL TECHNOLOGY

Technical Workplace Competencies and Course Crosswalk

	Computer Prog. Fundamentals	Engineering Graphics I	Mechanics	DC Circuit Analysis	Electricity and Magnetism	AC Circuit Analysis I	Electronic Devices	Fluids, Heat, Sound, and Light	AC Circuit Analysis II	Digital Fundamentals	Electromechanical Devices	Control Systems	Microcomputer Fundamentals	Programmable Controllers	Motor Controls	Introduction to Process Control	Control Systems II	Distributed Control Systems		EXIT PROFICIENCY LEVEL
F-3 Study Technical Equipment Information					I						R	R		R	R	R	R	R		3
F-4 Application of ISA/JIC Standards					I						R	R		R	R	R	R	M		4
F-5 Understand Proper Use of Test Equipment and Tools					I						R	R		R	R	R	R	R		4
F-6 Learn to Write Technical Reports					I						R	R		R	R	R	R	R		3
F-7 Acquire Safe Practices for Handling Hydraulic and Special Tools					I						R	R		R	R	R	R	R		3
F-8 Utilize Technical Manuals					I						R	R		R	R	R	R	M		4
F-9 Understand Personal Computers	I			R							R	R	M	R	R	R	R	R		4
F-10 Attend On-Going Safety Training Courses					I			R			R	R		R	R	R	R	R		4
F-11 Participate in Plant Related Training					I						R	R		R	R	R	R	R		4
F-12 Attend PLC Training													I		R		M			4
F-13 Attend DCS Training															I		R			3
G. MAINTAIN AND CONTROL INVENTORY																				
G-1 Learn to Review and Forecast Spare Parts Inventory			I						R	R		R	R	R	R	R			3	
G-2 Prepare Parts Request			I						R	R		R	R	R	R	R			3	
G-3 Verify Parts Received			I						R	R		R	R	R	R	R			3	
G-4 Research/Verify Substitute Specifications			I						R	R		R	R	R	R	R			2	
H. TROUBLESHOOT, INSTALL, MAINTAIN, AND OPERATE MOTOR CONTROL SYSTEMS																				
H-1 Troubleshoot, Install, Maintain, and Operate Motor Starters			I						R	R		R	M	R	R	R			4	
H-2 Troubleshoot, Install, Maintain, and Operate Relays			I						R	R		R	M	R	R	R			4	
H-3 Troubleshoot, Install, Maintain, and Operate Pushbuttons			I						R	R		R	M	R	R	R			4	
H-4 Troubleshoot, Install, Maintain, and Operate Switches			I						R	R		R	M	R	R	R			4	
H-5 Troubleshoot, Install, Maintain, and Operate DCS Networks			I						R	R		R	M	R	R	R			4	
H-6 Prepare and Update Ladder and/or Logic Diagrams			I								R				M				4	
H-7 Program PLCs											I				M				4	
H-8 Troubleshoot, Install, Maintain and Operate PLCs			I						R	R		R	M	R	R	R			4	

I=Introduced and Taught R=Repeated and Reinforced M=Mastered

SCANS

The Secretary's Commission on Achieving Necessary Skills (SCANS), U. S. Department of Labor, has identified in its "AMERICA 2000 REPORT" the following five competencies and a three–part foundation of skills and personal qualities that are needed for solid job performance:

COMPETENCIES:

Resources:	*Identifies, organizes, plans, and allocates resources*
Interpersonal:	*Works with others*
Information:	*Acquires and uses information*
Systems:	*Understands complex inter-relationships*
Technology:	*Works with a variety of technologies*

FOUNDATION SKILLS:

Basic Skills:	*Reads, writes, performs arithmetic and mathematical operations, listens, and speaks well*
Thinking Skills:	*Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn, and reasons*
Personal Qualities:	*Displays responsibility, self-esteem, sociability, self-management, integrity, and honesty*

Recognizing the value of SCANS proficiencies to job performance as well as the growing mandate in many states to include SCANS activities in course curricula, **MASTER** asked survey respondents to review the SCANS skill sets in the context of the draft skill standards for each occupational specialty area. **MASTER** also incorporated an evaluation of SCANS competencies and foundation skills into its assessment of the pilot training curricula. The results were summarized in a crosswalk that allowed the **MASTER** staff to modify course contents where needed to strengthen the achievement of SCANS competencies.

As soft skills, the SCANS competencies are inherently difficult to quantify. **MASTER** realizes that some faculty will emphasize the SCANS more or less than others. In time, faculty will learn to make these types of SCANS activities an integral and important part of the teaching process.

MASTER Curriculum
INSTRUMENTATION
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
FIRST QUARTER*				
MATH 191	College Algebra	5	0	5
ENGL 191	Composition and Rhetoric I	5	0	5
CIS 191	Computer Programming Fundamentals	3	6	5
DDF 191	Engineering Graphics I	1	6	3
		14	12	18
SECOND QUARTER*				
MATH 193	College Trigonometry	5	0	5
ENGL 195	Technical Communications	5	0	5
PHY 191	Mechanics	4	3	5
INT 101	DC Circuit Analysis	4	3	5
		18	6	20
THIRD QUARTER*				
MATH 195	Differential Calculus	5	0	5
PHY 192	Electricity and Magnetism	4	3	5
INT 102	AC Circuit Analysis I	4	3	5
INT 105	Electronic Devices	4	3	5
		17	9	20
FOURTH QUARTER*				
PHY 291	Fluids, Heat, Sound and Light	4	3	5
INT 103	AC Circuit Analysis II	4	3	5
INT 201	Digital Fundamentals	4	3	5
EMT 201	Electromechanical Devices	4	3	5
		16	12	20
FIFTH QUARTER*				
EMT 202	Control Systems	4	3	5
INT 203	Microcomputer Fundamentals	4	3	5
EMT 203	Programmable Controllers	3	3	4
EMT 253	Motor Controls	4	3	5
		15	12	19
SIXTH QUARTER*				
EMT 254	Introduction to Process Control (Technical Elective)	2	6	4
EMT 250	Control Systems II (Technical Elective)	4	3	5
EMT 251	Distributed Control Systems (Technical Elective)	3	3	4
PSY 191	Introductory Psychology (Social Science Elective)	5	0	5
		14	12	18
	Program Totals	94	63	115

***Each quarter is 10 weeks in length.**

MATH 191

MASTER PROGRAM

College Algebra

COURSE SYLLABUS

Total lecture hours: 50 **Total lab hours: 0** **Credit hours: 5**

COURSE DESCRIPTION:

Emphasizes techniques of problem solving using algebraic concepts. Topics include: algebraic concepts and operations, linear and quadratic equations and functions, simultaneous equations, inequalities, exponents and powers, graphing techniques, and analytic geometry.

PREREQUISITE: **Placement by diagnostic testing**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Utilizing fundamental laws of algebra to simplify algebraic expressions;
2. Solving systems of equations algebraically;
3. Computing the value of expressions involving exponents;
4. Converting numbers to scientific notation;
5. Converting written statements to algebraic expressions; and,
6. Solving word problems.

REQUIRED COURSE MATERIALS:

Textbook: *Basic Technical Mathematics with Calculus*, Latest Edition

Hand Tools/Quantity Required:

Scientific Calculator	1
Graph paper	1 pack
Pencils	
Straight edge	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and discussions.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Satisfactorily perform on written, oral, and practical examinations;
2. satisfactorily perform on outside assignments including writing assignments;
3. Contribute to class discussions; and,
4. Maintain attendance per current policy.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Numbers	5
Fundamental Laws & Operations of Algebra	
Calculators and Approximate Numbers	
Exponents	
Scientific Notation	
Roots and Radicals	
Addition and Subtraction of Algebraic Expressions	
Multiplication of Algebraic Expressions	
Division of Algebraic Expressions	
Solving Equations	5
Formulas and Literal Equations	
Applied Oral Problems	
Properties of Inequalities	5
Solving Linear Inequalities	
Introduction of Functions	
More About Functions	
Rectangular Coordinates	5
The Graph of a Function	
The Graphing Calculator	
Graphs of Functions by Tables of Data	
Linear Equations	5
Graphs of Linear Equations Basic Definitions	
The Straight Line	
The Ellipse	
Solving Systems of Two Linear Equations in Two Unknowns Graphically	5
Solving Systems of Two Linear Equations in Two Unknowns Algebraically	
Solving Systems of Two Linear Equations in Two Unknowns by Determinants	
Solving Systems of Three Linear Equations in Three Unknowns Algebraically	
Solving Systems of Three Linear Equations in Three Unknowns by Determinants	

Graphical Solution of Inequalities with Two Variables	5
Special Products	
Factoring: Common Factor and Difference of Squares	
Factoring Trinomials	5
The Sum and Difference of Cubes	
Equivalent Fractions	
Multiplication and Division of Fractions	
Addition and Subtraction of Fractions	
Equations Involving Fractions	5
Quadratic Equations: Solution by Factoring	
Completing the Square	
The Quadratic Formula	
The Graph of the Quadratic Function	
The Circle	5
The Ellipse	
The Hyperbola	
Review	
Final Exam	
Total Lecture Hours	**50**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- *A. Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- *B. Interpersonal: Works with others*

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. *Information: Acquires and uses information*
1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
b. Demonstrates ability to hear, comprehend, and appropriately follow directions
c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. *Speaking: Organizes ideas and communicates orally*
a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions

e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application

c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors

e. Demonstrates ability to accept and use constructive criticism

f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

ENGL 191

MASTER PROGRAM

Composition And Rhetoric I

COURSE SYLLABUS

Total lecture hours: 50 **Total lab hours: 0** **Credit hours: 5**

COURSE DESCRIPTION:

Explores the analysis of literature and articles about issues in the humanities and in society. Students practice various modes of writing, ranging from exposition to argumentation and persuasion. The course includes a review of standard grammatical and stylistic usage in proofreading and editing. An introduction to library resources lays the foundation for research. Topics include writing analysis and practice, revision, and research.

PREREQUISITE: NONE

COURSE OBJECTIVES:

Students who have successfully completed this course will be able to study, understand, and solve problems in:

1. Grammatical structure, as well as punctuation and other mechanics;
2. Writing clear, coherent, well-organized paragraphs;
3. Recognizing correct spelling in one's own or other's writing;
4. Presenting oral summaries outside reading;
5. Writing descriptions drawing details from observation;
6. Writing clear, coherent, well-organized explanations;
7. Successfully employ the various methods of development (including comparison and contrast, cause division, illustration, definition, classification, and division, argumentation, process), and choosing the appropriate form;
8. Articulating clean oral response to reading;
9. Identifying the major steps in conducting research; and,
10. Locating and using appropriate reference materials for written and oral reports.

REQUIRED COURSE MATERIALS:

Textbook: *From Idea to Essay*, Latest Edition

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Satisfactorily perform on written, oral, and practical examinations;
2. Satisfactorily perform on outside assignments including writing assignments;
3. Contribute to class discussions; and,
4. Maintain attendance per current policy.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Fundamentals of Grammar and Composition	**15**
Sentence elements	
Review of basic parts of speech	
Complete sentence paragraph, placement of modifiers, phrases, and clauses	
Paragraph construction	
Topic sentence	
Development	
Unity and coherence	
Transitional devices	
Spelling	
Fundamentals of Oral Communications	**8**
Presentation	
Mode of Written and Oral Communications	**15**
Description	
Exposition	
Argumentation and persuasion	
Oral communication	
Research	**12**
Steps	
References	
Total Lecture Hours	**50**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. Demonstrates ability to understand and perform multi-step computations
d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups

All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:*** ***Identifies, organizes, plans, and allocates resources***

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:*** ***Works with others***

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. ***Information:*** ***Acquires and uses information***

1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. ***Systems:*** ***Understands complex inter-relationships***

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. ***Technology:*** ***Works with a variety of technologies***

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: ***Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules***

f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. Demonstrates ability to detect problem through observation, inquiry, or directive
b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*

a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner

c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills

f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. ***Staircase to Writing and Reading,*** Costy, A., & Tighe, D. J., Englewood Cliffs, NJ: Prentice-Hall, Latest Edition
2. ***Harbrace College Handbook,*** Hodges, R. S., & Whitten, M. E., New York: Harcourt Brace Jovanovich, Latest Edition
3. ***Patterns for College Writing,*** Kirsner, L. G. & Mandel, S. R., New York: St. Martin's Press, Latest Edition
4. ***Readings for Writers,*** McCuen, J. R., & Winkler, A. C., New York: Harcourt Brace Jovanovich, Latest Edition
5. ***Rhetoric Made Plain,*** Winkler, A. C., & McCuen, J. R., New York: Harcourt Brace Jovanovich, Latest Edition

CIS 191

MASTER PROGRAM

Computer Programming Fundamentals

COURSE SYLLABUS

Total lecture hours: 30 **Total lab hours: 60** **Credit hours: 5**

COURSE DESCRIPTION:

Emphasizes fundamental concepts of problem solving using computers. Students explore flow charting, control structures, subroutines, arrays, strings manipulation, matrices, and files. A high level source language is used. The laboratory portion of the course is designed to acquaint students with computer facilities and software utilities. Topics include: system fundamentals, concepts of structured programming, functions and subroutines, data files, engineering applications, graphics, matrices, and program editing. Laboratory work parallels class work.

PREREQUISITE: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will study, understand, and solve problems in:

1. System fundamentals;
2. Concepts of structured programming (high level source language);
3. Arrays;
4. Functions and subroutines;
5. Data files;
6. Engineering applications;
7. Graphics;
8. Matrices; and,
9. Program editing.

REQUIRED COURSE MATERIALS:

Textbook: *Computer Currents*, George Beekman, Latest Edition

Supplies:
Flowchart template
Coding forms
Coding papers
Pencil
Pen

Notebook

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
DOS Overview	
QBASIC Overview	
QBASIC Environment	
Test 1	
Structured QBASIC Programs	
Test 2	
Midterm	
Arithmetic Expressions and Output	
Interactive Processes and Decisions	
Working with Words	
Calculation, Visualization, Simulation	
Final Exam	
Total Lecture Hours	**30**

LAB OUTLINE:

Lab Topic	Contact Hrs.
DOS Overview	
QBASIC Overview	
QBASIC Environment	
Structured QBASIC Programs	

Arithmetic Expressions and Output
Interactive Processes and Decisions
Working with Words
Calculation Visualization, Simulation

Total Lab Hours **60**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. *Resources: Identifies, organizes, plans, and allocates resources*
1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides feedback

B. *Interpersonal: Works with others*
1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. *Information: Acquires and uses information*
1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive

b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice

e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*

a. Presents a positive attitude toward tasks
b. Demonstrates ability to separate work and personal behaviors
c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. Demonstrates ability to accept and use constructive criticism
f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*

a. Demonstrates appropriate and acceptable social behaviors in interactions
b. Demonstrates ability to work cooperatively in individual, team, or group situations
c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner

d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   INT-B1;
   INT-B9;
   INT-B14; and,
   INT-F9.

DDF 191

MASTER PROGRAM

Engineering Graphics I

COURSE SYLLABUS

Total lecture hours: 10 **Total lab hours: 60** **Credit hours: 3**

COURSE DESCRIPTION:

Introduces engineering drawing. Topics include: sketching, drafting fundamentals such as use of instruments, linework, lettering, layout, and geometric construction; orthographic projection; pictorial drawing; schematic drawing; descriptive geometry; computer graphics concepts; and engineering drawing conventions. Laboratory work parallels class work.

PREREQUISITE: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Sketching;
2. Drafting fundamentals;
3. Orthographic projections;
4. Pictorial drawing;
5. Schematic drawing;
6. Descriptive geometry;
7. Computer graphics concepts; and
8. Engineering drawing conventions.

REQUIRED COURSE MATERIALS:

Textbook: *The AutoCAD Tutor for Engineering Graphics*, Kalameja, Alan J., Delmar Publishers, Latest Edition

Introduction to Engineering Drawing, Luzadder, Warren J.; Prentice Hall, Latest Edition

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and
7. Follow all lab rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction	1
Design Process and Graphics	1
Computer–Aided Design and Drafting	1
Freehand Sketching	1
Engineering Geometry	1
The Theory of Shape Description	1
The Theory of Size Description	1
Multiviews	1
Auxiliary Views	1
Sectional Views	1
Pictorial Views	1
Total Lecture Hours	**10**

LAB OUTLINE:

Lab Topics	Contact Hrs.
AutoCAD Basics	3
Object Construction and Manipulation	3
Geometric Constructions	3
Shape Description/Multi–View Projection	3
Dimensioning Techniques	6
Analyzing 2–D Drawings	6
Region Modeling Techniques	6
Section Views	6
Auxiliary Views	6
Isometric Drawings	6
3–D Modeling	6
Solid Modeling	6
Total Lab Hours	**60**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- *A. Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- *B. Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- *C. Information: Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information
- *D. Systems: Understands complex inter-relationships*
  1. Understands and works well with social, organizational, and technological systems
  2. Monitors and corrects performance of system during operation
  3. Recommends modifications to system to improve performance
- *E. Technology: Works with a variety of technologies*
  1. Chooses relevant procedures, tools, and equipment

2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
   a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations

b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. Demonstrates ability to detect problem through observation, inquiry, or directive
b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution

d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement

b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
c. Demonstrates ability to formulate and follow personal schedules
d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   INT-B2; and,
   INT-B13.

MASTER Curriculum
INSTRUMENTATION
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
FIRST QUARTER*				
MATH 191	College Algebra	5	0	5
ENGL 191	Composition and Rhetoric I	5	0	5
CIS 191	Computer Programming Fundamentals	3	6	5
DDF 191	Engineering Graphics I	1	6	3
		14	12	18
SECOND QUARTER*				
MATH 193	College Trigonometry	5	0	5
ENGL 195	Technical Communications	5	0	5
PHY 191	Mechanics	4	3	5
INT 101	DC Circuit Analysis	4	3	5
		18	6	20
THIRD QUARTER*				
MATH 195	Differential Calculus	5	0	5
PHY 192	Electricity and Magnetism	4	3	5
INT 102	AC Circuit Analysis I	4	3	5
INT 105	Electronic Devices	4	3	5
		17	9	20
FOURTH QUARTER*				
PHY 291	Fluids, Heat, Sound and Light	4	3	5
INT 103	AC Circuit Analysis II	4	3	5
INT 201	Digital Fundamentals	4	3	5
EMT 201	Electromechanical Devices	4	3	5
		16	12	20
FIFTH QUARTER*				
EMT 202	Control Systems	4	3	5
INT 203	Microcomputer Fundamentals	4	3	5
EMT 203	Programmable Controllers	3	3	4
EMT 253	Motor Controls	4	3	5
		15	12	19
SIXTH QUARTER*				
EMT 254	Introduction to Process Control (Technical Elective)	2	6	4
EMT 250	Control Systems II (Technical Elective)	4	3	5
EMT 251	Distributed Control Systems (Technical Elective)	3	3	4
PSY 191	Introductory Psychology (Social Science Elective)	5	0	5
		14	12	18
	Program Totals	94	63	115

***Each quarter is 10 weeks in length.**

Second Quarter

MATH 193

MASTER PROGRAM

College Trigonometry

COURSE SYLLABUS

Total lecture hours: 50 **Total lab hours: 0** **Credit hours: 5**

COURSE DESCRIPTION:

Emphasizes techniques of problem solving using trigonometric concepts. Topics include: trigonometric functions, properties of trigonometric functions, vectors and triangles, inverse of trigonometric functions/graphic, logarithmic and exponential functions, and complex numbers.

PREREQUISITE: **College Algebra**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Recognizing and verifying the basic trigonometric identities;
2. Performing algebraic operations with exponents expressed as integers or fractions;
3. Solving oblique triangles using the laws of sines and cosines;
4. Solving for an unknown angle using inverse trigonometric functions; and,
5. Solving exponential and logarithmic equations.

REQUIRED COURSE MATERIALS:

Textbook: *Basic Technical Mathematics with Calculus*, Latest Edition

Hand Tools/Quantity Required:

Scientific Calculator	1
Graph paper	1 pack
Pencils	
Straight edge	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and discussions.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Satisfactorily perform on written, oral, and practical examinations;
2. Satisfactorily perform on outside assignments including writing assignments;
3. Contribute to class discussions; and,
4. Maintain attendance per current policy.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Trigonometric Functions	**20**
Signs of the Trigonometric Functions	
Define the Six Trigonometric Functions	
Determine the Sign of the Function of an Angle	
Radians	
Perform Trigonometric Computations with Angles Measures in Radians	
Properties of Trigonometric Functions	**30**
Recognize and Verify the Basic Trigonometric Identities	
Trigonometric Equations (Conditional)	
Prove the Validity of Trigonometric Equations by Means of the Trigonometric Identities	
Positive Integers as Exponents	
Perform Algebraic Operations With Exponents Expressed as Integers or Fractions	
Zero and Negative Exponents	
Fractional Exponents	
Total Lecture Hours	**50**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. Resources: Identifies, organizes, plans, and allocates resources

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides feedback

B. Interpersonal: Works with others

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. Information: Acquires and uses information

1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. Systems: Understands complex inter-relationships

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. Demonstrates ability to understand and perform multi-step computations

d. Demonstrates ability to read, interpret, and use standard *measuring devices*
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. Demonstrates ability to objectively assess personal strengths and weaknesses
    b. Demonstrates ability to set realistic short-term and long-term goals
    c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    d. Demonstrates ability to identify potential pitfalls and take evasive actions
    e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery

b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time

e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors

b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

ENGL 195

MASTER PROGRAM

Technical Communications
COURSE SYLLABUS

Total lecture hours: 50 **Total lab hours: 0** **Credit hours: 5**

COURSE DESCRIPTION:

Emphasizes practical knowledge of technical communications techniques, procedures, and reporting formats used in industry and business. Topics include: research, device and process descriptions, formal technical report writing, business correspondence, and oral technical report presentation.

PREREQUISITE: **Composition and Rhetoric I**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand and solve problems in:

1. Using appropriate reference material in preparing a technical report;
2. Describing precisely in writing the characteristics and components of mechanisms and processes; and,
3. Preparing memo, business letters, and resume using accepted formats and style.

REQUIRED COURSE MATERIALS:

Textbook: *Technical Writing: A Practical Approach*, Pfeiffer, W. S., New York: Merrill, Latest Edition

Supplies:

Composition notebook (for students notes)
Loose leaf note paper (for class work submission)
Regulation report cover
Note cards (3x5 and 4x6 or 5x7)
Black or blue pen
Pencil

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, and discussions.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Satisfactorily perform on written and oral examinations;
2. Satisfactorily perform on outside assignments including writing assignments;
3. Contribute to class discussions; and,
4. Maintain attendance per current policy.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Reference Use and Research	5
Orientation: Process in Technical Writing, Technical Research	
Report: Informal Report, Including Internal Documentation (groups in class)	
Library Orientation	
Organizing Information Styles in Technical Writing	5
Organizing Information, Styles in Technical Writing	
Report: Topic Memo Due; Free-Write on Topic (in class)	
Informal Report Writing	5
Letters and Memos, Informal Reports	
Report: Problem Memo (groups in class); Purpose Statement; and, Informal Outline Due (handwritten drafts); Reference List Due (APA format in draft form)	
Formal Technical Report Writing	5
Formal Reports and Oral Communication	
Report: Abstract of Journal Article for Formal Report	
Patterns of Organization, Process Descriptions and Instructions	5
Report: Description of Mechanisms (groups in class); Note Cards Due	
Page Design, Graphics	5
Report: Purpose Statement Followed by Formal Outline Due (typed) (two copies); Progress Memo Due (one addressed to oral report)	
Drafting, Editing, and Revising	5
Report: Transmittal Memorandum Due; Rough Draft Due for Final Report	
Business Correspondence	5
The Job Search	
Report: Final Drafts Due (two copies; one for advisor)	
Oral Technical Report Presentation	5
Final Oral Presentations	

Report: Resumes (class discussion) Due Week 10
Review 5
Report: Final Oral Reports; Course Evaluation; and
Final Exam
Total Lecture Hours 50

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES
- A. *Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- B. *Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- C. *Information: Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information
- D. *Systems: Understands complex inter-relationships*

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

*1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

*2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. *Speaking: Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive

b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice

e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*

a. Presents a positive attitude toward tasks
b. Demonstrates ability to separate work and personal behaviors
c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. Demonstrates ability to accept and use constructive criticism
f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*

a. Demonstrates appropriate and acceptable social behaviors in interactions
b. Demonstrates ability to work cooperatively in individual, team, or group situations
c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner

d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

PHY 191

MASTER PROGRAM

Mechanics

COURSE SYLLABUS

Total lecture hours: 40 **Total lab hours: 30** **Credit hours: 5**

COURSE DESCRIPTION:

Introduces the classical theories of mechanics. Topics include: measurements and systems of units; Netwon's laws; work, energy, and power; impulse and momentum; linear motion and two–dimensional motion; equilibrium; and elasticity. Laboratory exercises supplement class work. Computer use is an integral part of class and laboratory assignments.

PREREQUISITE: **College Algebra;**
Computer Programming Fundamentals

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Measurements and systems of units;
2. Newton's laws;
3. Work, energy, and power;
4. Impulse and momentum;
5. One– and two–dimensional motion; and,
6. Mechanical equilibrium.

REQUIRED COURSE MATERIALS:

Textbook: *University Physics,* by William P. Crummet and Author B. Western, Latest Edition

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Measurements and Systems of Units	6
Scientific Notation	
Express and manipulate numbers in scientific notation	
Systems of Units	
Explain SI, CGS, and FPS unit systems	
Change a physical quantity from one set of units to another	
Vectors	
Explain the difference between vector and scalar quantities	
Express vector quantities in polar and component form	
Newton's Law	7
Newton's Laws of Motion	
State Newton's laws of motion	
Newton's Universal Law of Gravitation	
Calculate the gravitational attraction between two bodies	
Mass and Weight	
Distinguish between force and mass and define the units of each	
Application of Newton's Laws	
Solve dynamics problems involving constant forces	
Work, Energy and Power	7
Work, Energy and Power	
Define work, potential energy, kinetic energy and power, and identify the units of each	
Conservation of Energy	

State the law of conservation and energy

Work

Compute the work done by both constant and varying forces

Use the work–energy theorem in solving problems

Kinetic Energy

Compute the translational kinetic energy of a body

Hooke's Law

Solve problems with Hooke's law

Potential Energy

Compute the elastic potential energy stored in a spring

Compute the gravitational potential energy of an object

Power

Compute the power given appropriate parameters

Impulse and Momentum 7

Momentum

Define the momentum and identify its units

Conservation of Momentum

State the law of conservation of momentum

Elastic and Inelastic Collisions

Solve elastic and inelastic collision problems

One– and Two–Dimensional Motion 7

Displacement

Define displacement and identify its units

Velocity and Speed

Define both velocity and speed and identify their respective units

Acceleration

Define acceleration and identify its units

Motion and Constant Acceleration

Solve problems involving uniformly accelerated motion

Angular Displacement

Define angular displacement, angular velocity

Circular Motion

Define centripetal force and centripetal acceleration

Solve rotational kinematics problems

Calculate the centripetal force exerted on a body the associated centripetal acceleration

Mechanical Equilibrium 6

Torque

Define torque and identify its units

Compute the torque generated by a force about an axis

Moments of Inertia

Determine the moment of inertia of a rigid body about a given axis

Mechanical Equilibrium

State the conditions of mechanical equilibrium

Solve problems involving systems in the state of mechanical equilibrium

Conservation of Angular Momentum

State the law of conservation of angular momentum

Solve problems with conservation of angular momentum

Total Lecture Hours 40

LAB OUTLINE:

Lab Topics	Contact Hrs.
Measurements and Systems of Units	4
Scientific Notation	
Systems of Units	
Vectors	
Newton's Law	7
Newton's Laws of Motion	
Newton's Universal Law of Gravitation	
Mass and Weight	
Application of Newton's Laws	
Work, Energy and Power	4
Work, Energy and Power	
Conservation of Energy	
Work	
Kinetic Energy	
Hooke's Law	
Potential Energy	
Power	
Impulse and Momentum	4
Momentum	
Conservation of Momentum	
Elastic and Inelastic Collisions	
One and Two-Dimensional Motion	7
Displacement	
Velocity and Speed	
Acceleration	
Motion and Constant Acceleration	

Angular Displacement		
Circular Motion		
Mechanical Equilibrium		4
Torque		
Moments of Inertia		
Mechanical Equilibrium		
Conservation of Angular Momentum		
	Total Lab Hours	**30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- *A. Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- *B. Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- *C. Information: Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*
   1. Understands and works well with social, organizational, and technological systems
   2. Monitors and corrects performance of system during operation
   3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
   1. Chooses relevant procedures, tools, and equipment
   2. Applies appropriate procedures and techniques to accomplish tasks
   3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

   1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

   2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
      a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*

a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships

c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations

c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   INT-A1 through INT-A7; and,
   INT-B11.

INT 101

MASTER PROGRAM

DC Circuit Analysis

COURSE SYLLABUS

Total lecture hours: 40 **Total lab hours: 30** **Credit hours: 5**

COURSE DESCRIPTION:

Emphasizes the knowledge and ability to analyze basic DC circuits. Topics include: units, basic electrical laws, series and parallel circuits, capacitance, an introduction to network analysis and network theorem concepts, and DC instruments. Laboratory work parallels class work.

PREREQUISITE: **College Algebra;**
Computer Programming Fundamentals

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. International units (electrical measure)
2. Basic electrical laws;
3. Series and parallel circuits;
4. Capacitance;
5. Network analysis concepts;
6. Network theorem concepts; and,
7. DC instruments.

REQUIRED COURSE MATERIALS:

Textbook: *Introductory Circuit Analysis*, Boylstad, Latest Edition

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Conversion, Scientific Notation	
Current and Voltage	
Resistance	
Test 1	
Ohm's Law, Power, and Energy	
Series and Parallel Circuits	
Test 2	
Review and Midterm	
Series Parallel Circuits	
Test 3	
Network Analysis	
Network Theorems	
Capacitor	
Test 4	
Review and Final Exam	
Total Lecture Hours	**40**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Scientific Notation	3
Measure Voltage and Current, Voltmeter and Ammeter	3
Measure Resistance of Fixed and Variable Resistors	3
Measure Power, Wattmeter	3
Construct Series Circuit; Construct Parallel Circuit; Measure Voltage and Currents in Circuits	3
Construct Series and Parallel Circuits	3
Mesh Analysis	3
Norton's Theorem	3
Measure Capacitor Leakage Current and Charging Current	3
Complete All Labs	3
Total Lab Hours	**30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- *A. Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- *B. Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- *C. Information: Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information
- *D. Systems: Understands complex inter-relationships*
  1. Understands and works well with social, organizational, and technological systems
  2. Monitors and corrects performance of system during operation
  3. Recommends modifications to system to improve performance
- *E. Technology: Works with a variety of technologies*
  1. Chooses relevant procedures, tools, and equipment

2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. *Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
   a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. *Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations

b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution

d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
    a. Demonstrates appropriate and acceptable social behaviors in interactions
    b. Demonstrates ability to work cooperatively in individual, team, or group situations
    c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
    d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
    a. Accepts personal strengths and weaknesses and uses the same for positive advancement

b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
c. Demonstrates ability to formulate and follow personal schedules
d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
a. Knows and demonstrates ability to distinguish between positive and negative behaviors
b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
INT-A1 through INT-A7;
INT-B2;
INT-B4;
INT-B12;
INT-B14; and,
INT-C13.

MASTER Curriculum
INSTRUMENTATION
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
FIRST QUARTER*				
MATH 191	College Algebra	5	0	5
ENGL 191	Composition and Rhetoric I	5	0	5
CIS 191	Computer Programming Fundamentals	3	6	5
DDF 191	Engineering Graphics I	1	6	3
		14	12	18
SECOND QUARTER*				
MATH 193	College Trigonometry	5	0	5
ENGL 195	Technical Communications	5	0	5
PHY 191	Mechanics	4	3	5
INT 101	DC Circuit Analysis	4	3	5
		18	6	20
THIRD QUARTER*				
MATH 195	Differential Calculus	5	0	5
PHY 192	Electricity and Magnetism	4	3	5
INT 102	AC Circuit Analysis I	4	3	5
INT 105	Electronic Devices	4	3	5
		17	9	20
FOURTH QUARTER*				
PHY 291	Fluids, Heat, Sound and Light	4	3	5
INT 103	AC Circuit Analysis II	4	3	5
INT 201	Digital Fundamentals	4	3	5
EMT 201	Electromechanical Devices	4	3	5
		16	12	20
FIFTH QUARTER*				
EMT 202	Control Systems	4	3	5
INT 203	Microcomputer Fundamentals	4	3	5
EMT 203	Programmable Controllers	3	3	4
EMT 253	Motor Controls	4	3	5
		15	12	19
SIXTH QUARTER*				
EMT 254	Introduction to Process Control (Technical Elective)	2	6	4
EMT 250	Control Systems II (Technical Elective)	4	3	5
EMT 251	Distributed Control Systems (Technical Elective)	3	3	4
PSY 191	Introductory Psychology (Social Science Elective)	5	0	5
		14	12	18
	Program Totals	94	63	115

***Each quarter is 10 weeks in length.**

Third Quarter

MATH 195

MASTER PROGRAM

Differential Calculus

COURSE SYLLABUS

Total lecture hours: 50 **Total lab hours: 0** **Credit hours: 5**

COURSE DESCRIPTION:

Emphasizes the use of differential calculus. Application of techniques include extreme value problems, motion, graphing, and other topics as time allows. Topics include: derivatives and applications, differentiation of transcendental functions, and an introductions to integration and applications.

PREREQUISITE: College Trigonometry

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Finding the limits of equations using the four-step method;
2. Applying methods for differentiation—power rule, chain rule, implicit differentiation;
3. Differentiating exponential and logarithmic functions;
4. Evaluating indefinite integrals;
5. Calculating the area under a curve using a definite integral; and,
6. Evaluating integrals beyond the scope of this course by using integration tables.

REQUIRED COURSE MATERIALS:

Textbook: *Basic Technical Mathematics With Calculus*, Latest Edition

Hand Tools/Quantity Required:

Scientific Calculator	1
Graph paper	1 pack
Pencils	
Straight edge	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and discussions.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Satisfactorily perform on written, oral, and practical examinations;
2. Satisfactorily perform on outside assignments including writing assignments;
3. Contribute to class discussions; and,
4. Maintain attendance per current policy.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Functions (Notations, Range, Domain, Inverse, Operations, Graphing, Continuous)	5
Test 1	2
Limits	5
The Slope of a Tangent to a Curve	
The Derivative	
The Derivative as an Instantaneous Rate of Change	
Derivatives of Polynomials	
Derivatives of Products and Quotients of Functions	
The Derivative of a Power of a Function	
Differentiation of Implicit Functions	
Higher Derivatives	
Derivatives of the Sine and Cosine Functions	5
Derivatives of the Other Trigonometric Functions	
Derivative of the Logarithmic Function	
Derivative of the Exponential Functions	
Test 2	2
Tangents and Normals	5
Newton's Method for Solving Equations	
Curvilinear Motion	
Related Rates	
Using Derivatives in Curve Sketching	
More on Curve Sketching	
Applied Maximum and Minimum Problems	
Differentials	5
Test 3	2
Antiderivatives	
The Indefinite Integral	
The Area Under a Curve	
The Definite Integral	
Applications of the Indefinite Integral	5
Areas of Integration	

Other Applications		
Test 4		2
Review for Final Exam		5
Final Exam		2
	Total Lecture Hours	**50**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- A. *Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- B. *Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- C. *Information: Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information
- D. *Systems: Understands complex inter-relationships*

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds

f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking***: *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive

b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice

e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*

a. Presents a positive attitude toward tasks
b. Demonstrates ability to separate work and personal behaviors
c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. Demonstrates ability to accept and use constructive criticism
f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*

a. Demonstrates appropriate and acceptable social behaviors in interactions
b. Demonstrates ability to work cooperatively in individual, team, or group situations
c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner

d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

PHY 192

MASTER PROGRAM

Electricity and Magnetism

COURSE SYLLABUS

Total lecture hours: 40 **Total lab hours: 30** **Credit hours: 5**

COURSE DESCRIPTION:

Introduces theories of electricity and magnetism. Topics include: electrostatic forces and fields, magnetism, circuit elements and theory, electromagnetic waves, and modern physics. Laboratory exercises supplement class work.

PREREQUISITE: **College Trigonometry; Mechanics**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand and solve problems in:

1. Electrostatic forces and fields;
2. Magnetism;
3. Circuit elements and theory; and,
4. Electromagnetic waves.

REQUIRED COURSE MATERIALS:

Textbook: *University Physics*, by William P. Crummet and Author B. Western, Latest Edition;

Physics of Everyday Phenomena, by W. Thomas Griffith, Latest Edition

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands--on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Electrostatic Forces and Fields	10
Charges	
Identify the units of charge	
Conservation of Charge	
State the law of conservation of charge	
Conductors and Insulators	
Explain and demonstrate the difference between conductors and insulators	
Coulomb's Law	
Use Coulomb's law to calculate the force between point charges	
Electric Potential	
Compute the potential difference between two points in an electric field	
Capacitors	
Define capacitance and identify its units	
Calculate the capacitance of two parallel plates	
Magnetism	10
Magnetic Fields	
Define the concepts of a magnetic field and identify the units of the magnetic field	
Determine the magnitude and direction of the magnetic field produced by straight wires, loops and solenoids	
Magnetic Forces	
Explain the forces related to charge in motion	
Manual and Self–Inductance	
Calculate the magnitude and direction of an	

induced EMF using Faraday's law and Lenz's law

Generators and Transformers

State the principles associated with the behavior of motors and generators

Explain the principles associated with the behavior of transformers

Circuit Elements and Theory 10

Direct Current Circuits

Ohm's Law

Calculate the current, EMF, and effective resistance of series and parallel circuits

Kirchoff's Rules

Calculate the current at any point and the potential difference between any two points in a circuit using Kirchoff's rules

Alternating Current Circuits

Resistance

Calculate resistance

Reactance

Calculate the reactance

Inductance

Calculate the inductance

Phase Angles

Calculate the phase angles

Capacitance

Calculate the capacitance

Power

Calculate the reactance, impedance, current, voltage, power factor, power, and phase angle in AC circuits

Electromagnetic Waves 10

Maxwell's Equations

Recognize Maxwell's equations

Electromagnetic Wave Speed

Explain the relationship between the frequency, wavelength, and speed of electromagnetic waves

Electromagnetic Wave Energy

Explain the transport of energy by electromagnetic waves

Electromagnetic Spectrum

List the various types of electromagnetic waves according to their respective wavelengths —

Total Lecture Hours 40

LAB OUTLINE:

Lab Topics	Contact Hrs.
Electrostatic Forces and Fields	**9**
Charges	
Conservation of Charge	
Conductors and Insulators	
Coulomb's Law	
Electric Potential	
Capacitors	
Magnetism	**6**
Magnetic Fields	
Magnetic Forces	
Manual and Self-Inductance	
Lenz's law	
Generators and Transformers	
Circuit Elements and Theory	**9**
Direct Current Circuits	
Ohm's Law	
Kirchoff's Rules	
Alternating Current Circuits	
Resistance	
Reactance	
Inductance	
Phase Angles	
Capacitance	
Power	
Electromagnetic Waves	**6**
Maxwell's Equations	
Electromagnetic Wave Speed	
Electromagnetic Wave Energy	
Electromagnetic Spectrum	
Total Lab Hours	**30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. *Resources: Identifies, organizes, plans, and allocates resources*

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides feedback

B. *Interpersonal: Works with others*

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. *Information: Acquires and uses information*

1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. Demonstrates ability to understand and perform multi-step computations
d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking***: *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups

f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. Demonstrates ability to detect problem through observation, inquiry, or directive
b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*

a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner

c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills

f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   INT-A1 through INT-A7;
   INT-B1 through INT-B14;
   INT-C1 through INT-C23;
   INT-D2 through INT-D11;
   INT-E1 through INT-E8;
   INT-F1 through INT-F11;
   INT-G1 through INT-G4;
   INT-H1 through INT-H6; and,
   INT-H8.

INT 102

MASTER PROGRAM

AC Circuit Analysis I

COURSE SYLLABUS

Total lecture hours: 40 **Total lab hours: 30** **Credit hours: 5**

COURSE DESCRIPTION:

Emphasizes the knowledge and ability to analyze basic AC circuits. Topics include: magnetism, inductance\capacitance, alternating current, AC network theorems, admittance, impedance, phasors, complex power, and applications and use of appropriate instruments. Laboratory work parallels class work.

PREREQUISITE: DC Circuit Analysis;
College Trigonometry

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Magnetism;
2. Inductance/capacitance;
3. Alternating current;
4. AC network theorems;
5. Admittance;
6. Impedance;
7. Phasors;
8. Complex power; and,
9. Use appropriate instruments.

REQUIRED COURSE MATERIALS:

Textbook: *Introductory Circuit Analysis*, Boylstad, Latest Edition;

Introduction to Electric Circuits, Jackson, H. W., Latest Edition

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
AC Network Theorems	6
Thevenin's Theorem	
Analyze complex network	
Thevenin's Theorem	
Norton's Theorem	
Analyze a complex network using Norton's Theorem	
Admittance	6
Admittance Calculations	
Calculate the admittance of an AC circuit	
Impedance	6
Impedance Calculations	
Calculate the impedance in a complex circuit	
Phasors	6
AC Voltage and Current	
Calculate voltage and current calculations in an AC circuit using phasor analysis	
Complex Power	8
Circuit Reduction	
Reduce a complex network to an equivalent circuit using analysis technique	
Average Power	
Calculate the average power in an AC circuit	
Reactive Power	
Calculate the reactive power in an AC circuit	
Apparent Power	
Calculate the apparent power in an AC circuit	

Applications and Use of Instruments	**8**
Voltmeters	
Measure AC voltage using a voltmeter	
Ammeters	
Measure AC current using an ammeter	
Oscilloscope	
Measure voltage and frequency using an oscilloscope	—
Total Lecture Hours	**40**

LAB OUTLINE:

Lab Topics	**Contact Hrs.**
AC Network Theorems	**5**
Thevenin's Theorem	
Norton's Theorem	
Admittance	**5**
Admittance Calculations	
Impedance	**5**
Impedance Calculations	
Phasors	**5**
AC Voltage and Current	
Complex Power	**5**
Circuit Reduction	
Average Power	
Reactive Power	
Apparent Power	
Applications and Use of Instruments	**5**
Voltmeters	
Ammeters	
Oscilloscope	
Total Lab Hours	**30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. *Resources: Identifies, organizes, plans, and allocates resources*
   1. Allocates time to complete assigned tasks on schedule
   2. Determines and allocates required materials and resources for meeting objectives
   3. Evaluates skills, performance, and quality of work and provides feedback

B. *Interpersonal: Works with others*
   1. Participates as a member of the team, contributing to group effort
   2. Provides individual assistance/direction to peers as requested
   3. Determines and meets expectations
   4. Exercises leadership qualities to effectively communicate ideas and make decisions.
   5. Negotiates resources in order to accomplish objectives
   6. Works well with all members of the class

C. *Information: Acquires and uses information*
   1. Acquires and evaluates information
   2. Organizes and maintains information
   3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*
   1. Understands and works well with social, organizational, and technological systems
   2. Monitors and corrects performance of system during operation
   3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
   1. Chooses relevant procedures, tools, and equipment
   2. Applies appropriate procedures and techniques to accomplish tasks
   3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
   1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect

a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

c. Demonstrates ability to understand and perform multi-step computations
d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations

g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual

imagery and meet safety requirements for necessary machinery

b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion

d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*

a. Knows and demonstrates ability to distinguish between positive and negative behaviors
b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   INT-A1 through INT-A7;
   INT-B1;
   INT-B3;
   INT-B8 through INT-B9;
   INT-B12; and,
   INT-B14.

INT 105

MASTER PROGRAM

Electronic Devices

COURSE SYLLABUS

Total lecture hours: 40 **Total lab hours: 30** **Credit hours: 5**

COURSE DESCRIPTION:

Introduces the conduction process in semi–conductor materials. Topics include: semi–conductor physics; diodes; biasing; stability; and graphical analysis of bipolar junction transistors and field effect transistors; introduction to silicon controlled rectifiers; device curve characteristics; and related devices with selected applications. Laboratory work parallels class work.

PREREQUISITE: **DC Circuit Analysis;**
Composition & Rhetoric I;
College Trigonometry

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Semi–conductor physics;
2. Diodes;
3. Bipolar junction transistors;
4. Field effect transistors;
5. Silicon controlled rectifiers; and,
6. Device curve characteristics.

REQUIRED COURSE MATERIALS:

Textbook: *Introduction to Electronic Devices*, Latest Edition

Lab Manual: *Introduction to Electronic Devices*, Latest Edition

Hand Tools/Quantity Required:

VOM	1
Scope	1
Hand Tools	Varies
Calculator	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Semi-Conductor Physics	8
Atomic Theory for Semi-Conductors	
Determine the number of electrons in each shell for copper, silicon and germanium	
Silicon and Germanium Conduction	
Explain majority and minority current	
PN Junctions	
Explain the depletion region in a PN junction	
Diodes	8
Diode Models	
Draw the model for an ideal and practical diode	
Diode Applications	
Identify clipping and clamping circuits	
Bipolar Junction Transistors	8
PNP and NPN Atomic Characteristics	
Draw the forward and reverse characteristics for a PN junction	
BJT Operation	
Explain the current flow in a BJT	
Draw the symbols for a PNP and a NPN BJT	
Amplifying Action	
Explain how gain is achieved in a transistor	

Circuit Configurations: Common
Base (CB), Common Emitter (CE), Common Collector (CC)
Explain the characteristics for each transistor configuration
Specification Sheets
List the maximum ratings for BJTs
Transistor Biasing
List the four (4) main types of DC biasing networks

Field Effect Transistors	8

Junction Field Transistors
Explain the operation of the junction field effect transistor
JFET Biasing Circuits
Depletion MOSFET Biasing Circuits
Identify the three (3) main DC biasing networks
Enhancing MOSFET Biasing Circuits

Silicon Controlled Rectifiers	4

Thyistor Concepts
Zener Diodes
Diacs and Triacs Circuit Applications
Tunnel Diodes and Unijunction Transistors
Explain the operation of SCRs thyristors, Zener diodes, diacs and triacs, tunnel diodes, and unijunctional transistors

Device Curve Characteristics	4

Device Characteristics Plotting (Using Curve Tracer and Laboratory Equipment)
Draw the input and/or output characteristics for the following devices: BFT, JFET, depletion MOSFET, enhancement MOSFET, SCR, tracer, Zener diode, and regular diode

Total Lecture Hours	**40**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Diodes	15

Diode Models
Diode Applications

Bipolar Junction Transistors	9

PNP and NPN Atomic Characteristics
BJT Operation
Amplifying Action
Circuit Configurations: Common Base (CB), Common

Emitter (CE), Common Collector (CC)	
Specification Sheets	
Transistor Biasing	
Field Effect Transistors	3
Junction Field Transistors	
JFET Biasing Circuits	
Depletion MOSFET Biasing Circuits	
Enhancing MOSFET Biasing Circuits	
Silicon Controlled Rectifiers	3
Thyistor Concepts	
Zener Diodes	
Diacs and Triacs Circuit Applications	
Tunnel Diodes and Unijunction Transistors	—
Total Lab Hours	30

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- A. *Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- B. *Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.

5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. *Information: Acquires and uses information*
1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions

c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response

f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
    a. Demonstrates use of simple logic
    b. Demonstrates ability to distinguish relationships
    c. Demonstrates ability to determine and isolate factors in relationships
    d. Demonstrates and applies knowledge through practice
    e. Recognizes that attitudes, skills, and practice are essential to productivity
    f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
    a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
    b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
    c. Demonstrates ability to focus on task at hand and work to completion
    d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
    e. Demonstrates maturity to take responsibility for actions
    f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
    a. Presents a positive attitude toward tasks
    b. Demonstrates ability to separate work and personal behaviors
    c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
    d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
    e. Demonstrates ability to accept and use constructive criticism
    f. Accepts positive reinforcement in an appropriate manner

3. *Sociability: Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   INT-A1 through INT-A7;
   INT-B1 through INT-B9; and,
   INT-C32 through INT-C33.

MASTER Curriculum
INSTRUMENTATION
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
FIRST QUARTER*				
MATH 191	College Algebra	5	0	5
ENGL 191	Composition and Rhetoric I	5	0	5
CIS 191	Computer Programming Fundamentals	3	6	5
DDF 191	Engineering Graphics I	1	6	3
		14	12	18
SECOND QUARTER*				
MATH 193	College Trigonometry	5	0	5
ENGL 195	Technical Communications	5	0	5
PHY 191	Mechanics	4	3	5
INT 101	DC Circuit Analysis	4	3	5
		18	6	20
THIRD QUARTER*				
MATH 195	Differential Calculus	5	0	5
PHY 192	Electricity and Magnetism	4	3	5
INT 102	AC Circuit Analysis I	4	3	5
INT 105	Electronic Devices	4	3	5
		17	9	20
FOURTH QUARTER*				
PHY 291	Fluids, Heat, Sound and Light	4	3	5
INT 103	AC Circuit Analysis II	4	3	5
INT 201	Digital Fundamentals	4	3	5
EMT 201	Electromechanical Devices	4	3	5
		16	12	20
FIFTH QUARTER*				
EMT 202	Control Systems	4	3	5
INT 203	Microcomputer Fundamentals	4	3	5
EMT 203	Programmable Controllers	3	3	4
EMT 253	Motor Controls	4	3	5
		15	12	19
SIXTH QUARTER*				
EMT 254	Introduction to Process Control (Technical Elective)	2	6	4
EMT 250	Control Systems II (Technical Elective)	4	3	5
EMT 251	Distributed Control Systems (Technical Elective)	3	3	4
PSY 191	Introductory Psychology (Social Science Elective)	5	0	5
		14	12	18
	Program Totals	94	63	115

***Each quarter is 10 weeks in length.**

Fourth Quarter

PHY 291

MASTER PROGRAM

Fluids, Heat, Sound, and Light

COURSE SYLLABUS

Total lecture hours: 40 **Total lab hours: 3** **Credit hours: 5**

COURSE DESCRIPTION:

Introduces classical theories of fluids, heat, sound, and light. Topics include: statics and dynamics of fluids, gas laws, heat transfer, thermodynamics, simple harmonic motion, wave motion, sound, and properties of light. Laboratory exercises supplement class work. Computer use is an integral part of the class and laboratory assignments.

PREREQUISITE: **College Trigonometry; Mechanics**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Statics and dynamics of fluids;
2. Gas laws;
3. Heat transfer;
4. Thermodynamics;
5. Harmonic motion;
6. Wave motion;
7. Sound; and,
8. Properties of light.

REQUIRED COURSE MATERIALS:

Textbook: *University Physics,* by William Crummet and Author B. Western, Latest Edition

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Statics and Dynamics of Fluids	5
States of Matter	
Define the three states of matter	
Density	
Define density and identify its units	
Pressure	
Define pressure and identify its units	
Determine the pressure in a fluid column of known density	
Archimedes' Principle	
Determine the buoyant force of an object	
Bernoulli's Equation	
Solve problems with Bernoulli's equation	
Heat Transfer	5
Quantity of Heat	
Explain the difference between the terms of heat energy and internal energy	
Identify the units of heat energy	
Calorimetry	
Solve calorimetry problems	
Thermal Expansion	
Solve problems on thermal expansion with the expansion coefficients	
Heat Transfer	
Explain the three basic avenues of heat transfer	
Thermodynamics	5
State Variables	
Explain the concept of a state variable	

First Law of Thermodynamics
- Solve problems using the first law of thermodynamics

Typical Processes in Gases
- Explain the four basic thermodynamic processes and the concept of a cyclic thermodynamic process
- Demonstrate the use of P–V diagrams

Heat Engines
- Define the thermal efficiency
- Determine the efficiency of a heat engine

Second Law of Thermodynamics
- Explain the second law of thermodynamics

Harmonic Motion 5

Stress
- Define stress and identify its units
- Calculate stress

Strain
- Define strain and identify its units

Moduli of Elasticity
- Calculate the moduli of elasticity

Simple Harmonic Motion
- Solve problems involving simple harmonic motion

Wave Motion 5

Mechanical Waves
- Define the terms used to describe the properties of waves

Reflection of Waves
- Explain wave reflection and the principle of superposition
- Explain standing waves
- Compute wavelength, frequency, and speed of various types of waves
- Explain the difference between transverse and longitudinal waves

Sound 5

Sound Waves
- Explain the nature of sound as a compressional wave

Intensity
- Explain the concepts of intensity and intensity level

Beats
- Explain the phenomenon of beats

Resonance
- Compute the resonant frequency of a system given appropriate data

Doppler Effect
- Explain the Doppler effect and compute frequency shift given appropriate data

Properties of Light 10

Speed of Light
- Determine the speed of light in various media

Wave–Particle Duality
- Demonstrate knowledge of dual nature of light

Reflection
- Explain reflection and image formation by plane and spherical mirrors

Refraction
- Explain refraction and image formation by lenses
- Solve problems using Snell's law

Interface and Diffraction
- Explain double slit interference patterns
- Explain the behavior of diffraction gratings

Total Lecture Hours 40

LAB OUTLINE:

Lab Topics	Contact Hrs.
Liquids	3
Temperature and Heat	6
Thermodynamics I	3
Momentum	4
One Dimensional Waves	4
Sound	4
Reflection, Refraction and Polarization of Light	6
Total Lab Hours	30

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance.

All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- A. *Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- B. *Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- C. *Information: Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information
- D. *Systems: Understands complex inter-relationships*
  1. Understands and works well with social, organizational, and technological systems
  2. Monitors and corrects performance of system during operation
  3. Recommends modifications to system to improve performance
- E. *Technology: Works with a variety of technologies*
  1. Chooses relevant procedures, tools, and equipment
  2. Applies appropriate procedures and techniques to accomplish tasks
  3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

- A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
  1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. Demonstrates ability to understand and perform multi-step computations
d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups

f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. Demonstrates ability to detect problem through observation, inquiry, or directive
b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*

a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
a. Demonstrates mastery of basic reading, math, and language skills through application
b. Demonstrates ability to translate abstract theory into practical application
c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
d. Demonstrates knowledge of good study skills and learning habits

5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
a. Demonstrates use of simple logic
b. Demonstrates ability to distinguish relationships
c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. *Responsibility: Exerts a high level of effort and perseveres towards goal attainment*
a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner

c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills

f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Additional Reference Materials:

1. MASTER Technical Modules:
   INT-A1 through INT-A7;
   INT-B1 through INT-B14;
   INT-C1 through INT-C2;
   INT-C5 through INT-C7;
   INT-C12;
   INT-C21;
   INT-D2;
   INT-D5;
   INT-E1; and,
   INT-E4.
2. ***Physics of Everyday Phenomena,*** by W. Thomas Griffith, Latest Edition
3. ***University Physics Solutions Manual,*** Latest Edition

INT 103

MASTER PROGRAM

AC Circuit Analysis II

COURSE SYLLABUS

Total lecture hours: 40 **Total lab hours: 30** **Credit hours: 5**

COURSE DESCRIPTION:

Continues study of AC circuit analysis with emphasis on transient analysis and network theorems. Topics include: analysis of complex networks, resonance, transformers, multiple sources, three–phase systems, an introduction to filters and bode plots, and non–sinusoidal waveforms. Laboratory work parallels class work.

PREREQUISITE: **AC Circuit Analysis I; Differential Calculus**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Analysis of complex networks;
2. Resonance;
3. Transformers;
4. Multiple sources;
5. Three–phase systems;
6. Non–sinusoidal waveforms;
7. Transient analysis; and,
8. Filters and bode plots.

REQUIRED COURSE MATERIALS:

Textbook: *Introductory Circuit Analysis,* Boylstad, Latest Edition

Supplemental Text: *Principles of Electric Circuits,* T.L. Floyd, Latest Edition

Fundamentals of Electric Circuits, David Bell, Latest Edition

Introduction to Electric Circuits, Jackson, H.W., Latest Edition

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Series–Parallel AC Networks	
Methods of Analysis and Selected Topics (Mesh and Nodal)	
Network Theorems: Norton, Thevenin, and Superposition	
EXAM 1	
Power (AC) Resistive and Apparent Inductive and Reactive	
Series–Parallel Resonance Quality Factor Curve; Selectivity Series–Parallel	
EXAM 2	
Attenuation and Bode Plots Low Pass, High Pass, Band Pass and Band–Stop	
Polyphase System Y–Delta Generators	
Non–Sinusoidal Circuits	
Transformers	
FINAL EXAM	
Total Lecture Hours	**40**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Construct AC Ladder Series—Parallel Circuit	3
Construct AC Mesh and Nodal Circuit	3
Construct Norton Network Theorem	3

Construct Thevenin Theorem	3
Measure Apparent, Resistant and Reacting Power	3
Build Resonance Circuits; Measure Quality Factor	3
Build Filters—Low Pass, High Pass, Band Pass, and Band–Stop	3
Wire Delta 1 Y–Generators, Measure Voltages	3
Computer Addition of Non–Sinusoidal Waveforms	3
Wire Transformers, Measure Voltage and Impedance	3
Total Lab Hours	**30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- *A. Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- *B. Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- *C. Information: Acquires and uses information*
  1. Acquires and evaluates information

2. Organizes and maintains information
3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. *Speaking: Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships

c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*

a. Presents a positive attitude toward tasks
b. Demonstrates ability to separate work and personal behaviors
c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. Demonstrates ability to accept and use constructive criticism
f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*

a. Demonstrates appropriate and acceptable social behaviors in interactions
b. Demonstrates ability to work cooperatively in individual, team, or group situations

c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   INT-A1 through INT-A7;
   INT-B2;
   INT-B4;
   INT-B6 through INT-B9;
   INT-B11 through INT-B12;
   INT-B14; and,
   INT-F10.

INT 201

MASTER PROGRAM

Digital Fundamentals

COURSE SYLLABUS

Total lecture hours: 40 **Total lab hours: 30** **Credit hours: 5**

COURSE DESCRIPTION:

Introduces digital electronics. Topics include: fundamental of digital techniques, integrated logic circuits involving number systems, logic symbols and gates, Boolean algebra, and optimization techniques, flip–flops and registers; combinational and sequential logic circuits; and memory circuits. Laboratory work parallels class work.

PREREQUISITE: **AC Circuit Analysis I**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Fundamentals of digital techniques;
2. Integrated Logic Circuits;
3. Flip–flops and registers;
4. Sequential logic circuits;
5. Combinational logic circuits; and,
6. Memory circuits.

REQUIRED COURSE MATERIALS:

Textbook: ***Digital System Principles & Applications,*** Ronald J. Tocci, Prentice Hall (Englewood Cliffs, New Jersey), Latest Edition

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Numbering System; Parallel and Serial Transmission	
Numbering System Conversion; BCD Code; Parity Method for Error Detection	
Boolean Constants and Variables; Truth Tables	
EXAM 1	
Combination Logic Circuits; Sum of Product; Product of Sum; Karnaugh Map; EX–OR and Not Exclusive OR Gate	
Flip-Flops and Related Topics; Clocked S–C, J–K, D Flip Flop; Asynchronous Inputs	
EXAM 2	
Add, Subtract, Divide, and Multiply in Numbering Systems; BCD Addition; 1's and 2's Complement System	
Async. And Sync. Counters; Up and Down Counters; Decoding a Counter; Registers and Memory	
FINAL	
Total Lecture Hours	**40**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Numbering System; Parallel and Serial Transmission	
Numbering System Conversion; BCD Code; Parity Method for Error Detection	
Boolean Constants and Variables; Truth Tables	
EXAM 1	
Combination Logic Circuits; Sum of Product; Product of Sum; Karnaugh Map; EX–OR and Not Exclusive OR Gate	
Flip-Flops and Related Topics; Clocked S–C, J–K, D Flip	

Flop; Asynchronous Inputs
EXAM 2
Add, Subtract, Divide, and Multiply in Numbering Systems; BCD Addition; 1's and 2's Complement System
Async. And Sync. Counters; Up and Down Counters; Decoding a Counter; Registers and Memory
FINAL

Total Lab Hours **30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. Resources: Identifies, organizes, plans, and allocates resources

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides feedback

B. Interpersonal: Works with others

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. Information: Acquires and uses information

1. Acquires and evaluates information

2. Organizes and maintains information
3. Interprets and communicates information

D. Systems: Understands complex inter-relationships

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. Technology: Works with a variety of technologies

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

*1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

*2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*

a. Demonstrates appropriate listening and speaking skills in personal conversations
b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes
   g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships

c. Demonstrates ability to determine and isolate factors in relationships
d. Demonstrates and applies knowledge through practice
e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*

a. Presents a positive attitude toward tasks
b. Demonstrates ability to separate work and personal behaviors
c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
e. Demonstrates ability to accept and use constructive criticism
f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*

a. Demonstrates appropriate and acceptable social behaviors in interactions
b. Demonstrates ability to work cooperatively in individual, team, or group situations

c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. *Self-Management: Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   INT-A1 through INT-A7;
   INT-B1 through INT-B9;
   INT-C26; and,
   INT-C32 through INT-C33.

EMT 201

MASTER PROGRAM

Electromechanical Devices

COURSE SYLLABUS

Total lecture hours: 40 **Total lab hours: 30** **Credit hours: 5**

COURSE DESCRIPTION:

Introduces electromechanical devices which are essential control elements in electrical systems. Topics include: fundamentals of electromechanical devices, control elements in electrical circuits, typical devices such as generators and alternators, DC and AC motors and power factors, and efficiencies in DC, single–phase and three–phase dynamos are stressed. Laboratory work parallels class work.

PREREQUISITE: **AC Circuit Analysis I**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Fundamentals of electromechanical devices;
2. Control elements in electrical circuits;
3. Generators and alternators;
4. DC motors and controls;
5. AC motors and controls;
6. Transformers; and,
7. Synchromechanisms.

REQUIRED COURSE MATERIALS:

Textbook: *Electric Circuits and DC Machines,* by E.C. Lister, Latest Edition

Hand Tools/Quantity Required:

Calculator
Screwdrivers (flathead and phillips head)
Diagonal pliers

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Switches, Fuses, Relays and Circuit Breakers	
Test on Switches, Fuses, Relays and Circuit Breakers	
Magnetism and Electromagnetism	
Test on Magnetism and Electromagnetism	
Transformers—Principle of Operation, Voltage Ration, Turns Ration, Current Ration, Losses, Efficiency	
Solve Problems From Handout	
Test on transformers	
DC Generators—Principles of Operation, Different Types, Characteristics	
Solve Problems	
Field Trip (near end of quarter)	
Alternators—Principle of Operation, Characteristics, Operating in Parallel (Synchronizing)	
Solve Problems From Handout	
Test on Generators and Alternators	
Review of Weeks 1–5	
Midterm	
DC Motors—Principle of Operation, Types, Characteristics, Basic Motor Control Methods	
Solve Problems	
AC Motors (3–Phase)—Principle of Operation, Types, Power Factor, Slip	
NEMA Classification and Class of Insulation	
Test on DC Motors and 3–Phase AC Motors	
Single–Phase AC Motors—Principle of Operation, Types, Characteristics	
Synchromechanism Systems—Synchrotransmitter, Synchro Receiver	

Simplified Circuits on Synchro Systems
Test on Single Phase AC Motors and Synchro Systems
Review
Final Exam

Total Lecture Hours 40

LAB OUTLINE:

Lab Topics	Contact Hrs.
Switches Used in Common Control Circuits	
Transformers	
Single Phase AC Motors	
3–Phase Motors	
Single Phase Motors	
Total Lab Hours	**30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

*A. **Resources:** Identifies, organizes, plans, and allocates resources*

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides feedback

*B. **Interpersonal:** Works with others*

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. *Information: Acquires and uses information*
   1. Acquires and evaluates information
   2. Organizes and maintains information
   3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*
   1. Understands and works well with social, organizational, and technological systems
   2. Monitors and corrects performance of system during operation
   3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
   1. Chooses relevant procedures, tools, and equipment
   2. Applies appropriate procedures and techniques to accomplish tasks
   3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

   1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
      b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
      c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
      d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
      e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

   2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
      a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately

e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. *Speaking: Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive

b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity

f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*

a. Accepts personal strengths and weaknesses and uses the same for positive advancement
b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
c. Demonstrates ability to formulate and follow personal schedules
d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
a. Knows and demonstrates ability to distinguish between positive and negative behaviors
b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
INT-A1 through INT-A7;
INT-B1 through INT-B14;
INT-C1 through INT-C36
INT-D2 through INT-D3;
INT-F1 through INT-F11;
INT-G1 through INT-G4;
INT-H1 through INT-H5; and,
INT-H8.

MASTER Curriculum
INSTRUMENTATION
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
FIRST QUARTER*				
MATH 191	College Algebra	5	0	5
ENGL 191	Composition and Rhetoric I	5	0	5
CIS 191	Computer Programming Fundamentals	3	6	5
DDF 191	Engineering Graphics I	1	6	3
		14	12	18
SECOND QUARTER*				
MATH 193	College Trigonometry	5	0	5
ENGL 195	Technical Communications	5	0	5
PHY 191	Mechanics	4	3	5
INT 101	DC Circuit Analysis	4	3	5
		18	6	20
THIRD QUARTER*				
MATH 195	Differential Calculus	5	0	5
PHY 192	Electricity and Magnetism	4	3	5
INT 102	AC Circuit Analysis I	4	3	5
INT 105	Electronic Devices	4	3	5
		17	9	20
FOURTH QUARTER*				
PHY 291	Fluids, Heat, Sound and Light	4	3	5
INT 103	AC Circuit Analysis II	4	3	5
INT 201	Digital Fundamentals	4	3	5
EMT 201	Electromechanical Devices	4	3	5
		16	12	20
FIFTH QUARTER*				
EMT 202	Control Systems	4	3	5
INT 203	Microcomputer Fundamentals	4	3	5
EMT 203	Programmable Controllers	3	3	4
EMT 253	Motor Controls	4	3	5
		15	12	19
SIXTH QUARTER*				
EMT 254	Introduction to Process Control (Technical Elective)	2	6	4
EMT 250	Control Systems II (Technical Elective)	4	3	5
EMT 251	Distributed Control Systems (Technical Elective)	3	3	4
PSY 191	Introductory Psychology (Social Science Elective)	5	0	5
		14	12	18
	Program Totals	94	63	115

***Each quarter is 10 weeks in length.**

Fifth Quarter

EMT 202

MASTER PROGRAM

Control Systems

COURSE SYLLABUS

Total lecture hours: 40 **Total lab hours: 30** **Credit hours: 5**

COURSE DESCRIPTION:

Introduces control system components and theory as they relate to controlling industrial processes. Mechanical, fluids, temperatures, and miscellaneous sensors are studied with emphasis on measuring techniques. Topics include: open– and closed–loop control theory, feedback, transducers, signal conditioning, and control hardware and actuators. Laboratory work parallels class work.

PREREQUISITE: **Digital Fundamentals**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Open and closed loop control theory;
2. Feedback;
3. Transducers; and,
4. Control hardware and actuators.

REQUIRED COURSE MATERIALS:

Textbook: *Instrumentation,* Kirk & Rimboi, American Technical Publishers, Latest Edition

Lab Manual: *Automated Process Control Systems,* Hunter, Ronald P., Technical Publishing Corporation Books, 111, 112, 113, 221*, 222*, 223*, 230 (*strongly recommended), Latest Edition

Hand Tools/Quantity Required:

Plastic Tool Box
Screwdriver
Pliers
Wrench

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction to Process Control and Level ISA Symbols	4
Flow	4
Measurement and Temperature	4
Measurements Pressure	4
Analysis	4
Analysis Control	8
Control	4
(On–Off)—Proportional - + Reset + Derivative	4
Review and Final Exam	4
Total Lecture Hours	**40**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Draw a level control loop	3
Draw a flow control loop	3
Draw a temperature control loop	3
Draw a pressure control loop	3
Draw a density control loop	3
Draw a multi-loop control	15
Total Lab Hours	**30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- *A. Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- *B. Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- *C. Information: Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information
- *D. Systems: Understands complex inter-relationships*
  1. Understands and works well with social, organizational, and technological systems
  2. Monitors and corrects performance of system during operation
  3. Recommends modifications to system to improve performance
- *E. Technology: Works with a variety of technologies*
  1. Chooses relevant procedures, tools, and equipment

2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
   a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations

b. Demonstrates ability to choose and organize appropriate words to effectively communicate
c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution

d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement

b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
c. Demonstrates ability to formulate and follow personal schedules
d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
a. Knows and demonstrates ability to distinguish between positive and negative behaviors
b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
INT-A1 through INT-A7;
INT-B1 through INT-B14;
INT-C1 through INT-C36;
INT-D1 through INT-D11;
INT-F1 through INT-F11;
INT-G1 through INT-G4;
INT-H1 through INT-H5; and,
INT-H8.

INT 203

MASTER PROGRAM

Microcomputer Fundamentals

COURSE SYLLABUS

Total lecture hours: 40 **Total lab hours: 30** **Credit hours: 5**

COURSE DESCRIPTION:

Continues the study of digital electronics. Topics include: computer arithmetic, analog to digital and digital to analog conversion, microcomputer architecture, and machine level and assembly level language programming. Laboratory work parallels class work.

PREREQUISITE: **Electronic Devices;**
Digital Fundamentals

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Arithmetic and logic;
2. Conversions (digital/analog and analog/digital);
3. Microcomputer architecture;
4. Machine level language programming; and,
5. Assembly level language programming.

REQUIRED COURSE MATERIALS:

Textbook: *The 6800 Microprocessor*, Latest Edition

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;

5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Arithmetic and Logic	8
Adder Circuits	
Explain the operation of full and half adder circuits	
Encoder/Decoder Circuits	
Explain the operation of encoder/decoder circuitry	
Conversions	8
Digital to Analog	
Construct digital/analog convertors using operational–amplifier summing circuits	
Analyze the operation of current DACs	
Determine the resolution and accuracy of a DAC	
Analog to Digital	
Construct an A/D converter using comparators, D/A convertors, binary counters, and logic gates	
Analyze the operation of a successive approximation ADC	
Microcomputer Architecture	8
Tri–State Bus	
Explain how data is transferred between registers connected by a tri–state bus	
System Layout	
Draw a block diagram showing the relationship between system components linked by address, data and control busses	
Machine Level Language Programming	8
Machine Code	
Analyze instruction words, data and address words	
Explain how control words activate memory and other registers	
Analyze the operation of program counters, stack registers, instruction registers, and memory address registers	
Analyze read and write operations	
Assembly Level Language Programming	8
Assembly Language Codes	
Identify assembly language operation codes	
Write assembly language programs to store and retrieve data	
Total Lecture Hours	**40**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Arithmetic and Logic	**6**
Adder Circuits	
Encoder/Decoder Circuits	
Conversions	**6**
Digital to Analog	
Analog to Digital	
Microcomputer Architecture	**6**
Tri-State Bus	
System Layout	
Machine Level Language Programming	**6**
Machine Code	
Assembly Level Language Programming	**6**
Assembly Language Codes	
Total Lab Hours	**30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:*** ***Identifies, organizes, plans, and allocates resources***

1. **Allocates time to complete assigned tasks on schedule**
2. **Determines and allocates required materials and resources for meeting objectives**
3. **Evaluates skills, performance, and quality of work and provides feedback**

B. ***Interpersonal:*** ***Works with others***

1. **Participates as a member of the team, contributing to group effort**
2. **Provides individual assistance/direction to peers as requested**
3. **Determines and meets expectations**
4. **Exercises leadership qualities to effectively communicate ideas and make decisions.**

5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. *Information: Acquires and uses information*
1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*
1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

*1. **Reading:** Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

*2. **Writing:** Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted

grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages

b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems

c. Demonstrates ability to understand and perform multi-step computations

d. Demonstrates ability to read, interpret, and use standard measuring devices

e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively

f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance

g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*

a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery

b. Demonstrates ability to hear, comprehend, and appropriately follow directions

c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction

d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. *Speaking: Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. Demonstrates ability to detect problem through observation, inquiry, or directive
b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice

e. Recognizes that attitudes, skills, and practice are essential to productivity
f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
   e. Demonstrates maturity to take responsibility for actions
   f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner
2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions
5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   INT-A1 through INT-A7;
   INT-B9; and,
   INT-F9.

EMT 203

MASTER PROGRAM

Programmable Controllers

COURSE SYLLABUS

Total lecture hours: 30 **Total lab hours: 30** **Credit hours: 4**

COURSE DESCRIPTION:

Emphasizes an in–depth study of the programmable controller with programming applications involving controlling industrial processes. Topics include: input and output modules, logic units, memory units, power supplies, ladder diagrams, relay logic timers and counters, control strategy, programming and troubleshooting. Networking is introduced and communications protocol is investigated. Lab work parallels class work.

PREREQUISITE: **Digital Fundamentals**

COREQUISITE: **Electromechanical Devices**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Controller hardware;
2. Control strategy;
3. Ladder diagrams;
4. Input/output modules;
5. Programming; and,
6. Troubleshooting.

REQUIRED COURSE MATERIALS:

Textbook: *Technician's Guide to Programmable Logic Controllers,* by Cox, Latest Edition

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Introduction and Hardware	
Basic Concepts	
Test 1	
Program Panels and Relay Equivalents	
Test 2	
Timers, Counters, and Data Manipulation	
Test 3	
User Program and Editing Functions	
Test 4	
Coding and Documentation of Program	
Review Program	
Total Lecture Hours	**30**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Identify and List Functions of the Various Sections of a Programmable Controller System	
Locate and Identify the Functions of the Various Diagnostic Indicators	
Assign an Address to Designated Terminals	
Identify the Address of Words in Memory	
Enter Various Rungs Using PC Equipment	
Identify the Various Types of Instructions Using PC Equipment	
Troubleshoot the PC System, MSQD and AB 5/10	
Total Lab Hours	**30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- *A. Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. . Evaluates skills, performance, and quality of work and provides feedback
- *B. Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- *C. Information: Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information
- *D. Systems: Understands complex inter-relationships*
  1. Understands and works well with social, organizational, and technological systems
  2. Monitors and corrects performance of system during operation
  3. Recommends modifications to system to improve performance
- *E. Technology: Works with a variety of technologies*
  1. Chooses relevant procedures, tools, and equipment
  2. Applies appropriate procedures and techniques to accomplish tasks

3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
   a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate

c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. Demonstrates ability to detect problem through observation, inquiry, or directive
b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement

b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
c. Demonstrates ability to formulate and follow personal schedules
d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   INT-A1 through INT-A7;
   INT-B1 through INT-B14;
   INT-C1 through INT-C36;
   INT-F1 through INT-F12;
   INT-G1 through INT-G4; and,
   INT-H1 through INT-H8.

EMT 253

MASTER PROGRAM

Motor Controls

COURSE SYLLABUS

Total lecture hours: 40 **Total lab hours: 30** **Credit hours: 5**

COURSE DESCRIPTION:

Emphasizes the principles of motor controls from fractional horsepower to large magnetic starters, including starting polyphase induction, synchronous, wound rotor and direct current motors. Topics includes: control pilot devices, control circuits and AC reduced voltage starters, three–phase induction, wound rotor, and synchronous motor controls, DC motors, and solid state motor controls.

PREREQUISITE: **Electromechanical Devices**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Control pilot devices;
2. Control circuits and AC reduced voltage starters;
3. Three–phase induction, wound rotor, and synchronous motor controls;
4. DC motors; and,
5. Solid state motor controls.

REQUIRED COURSE MATERIALS:

Textbook: *Industrial Motor Controls*, W. Alerich, Latest Edition;

ETM, Latest Edition

Lab Manual: *Solid State DC Motor Control Laboratory Manual*, Latest Edition

Hand Tools/Quantity Required:

VOM	1
Hand Tools	varies

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Three–Phase Circuits Review	
General Principles of Motor Control	
Fractional Horsepower	
Starters	
Magnetic Line Voltage Starters, Control Stations	
Relays and Contactors	
Test #1	
Timing Devices, Pilot Devices	
Control Circuits and Symbols,	
Schematic and Wiring Diagrams,	
Conversion From Wiring to Schematic	
Test #2	
Diagrams and Basic Control Circuits, Three–Phase	
Induction Motor	
Midterm	
Single–Phase Induction Motor, Interlocking Methods,	
Various Reduced Voltage Starting Multi Speed	
Induction Motors and Their Controls	
Wound Rotor Motor Theory and Operation	
Manual and Automatic Acceleration of Wound Rotor Motor	
Test #3	
Synchronous Motor Theory and Operations	

Synchronous Motor Controls
DC Motor Theory and Operations
DC Motor Controls
Test #4
Introduction to Solid State Motor Control, Variable Speed DC Drives
Test #5
Variable Frequency Speed Control, Static Logic Control
Review for Final Exam

Total Lecture Hours 40

LAB OUTLINE:

Lab Topics	Contact Hrs.
Connect a Push-Button Station to Operate a Relay and a Motor (Three-wire Control) (Two Wire Control)	
Connect a Selector Switch (Hands–on Automatic) and Pressure Switch (Substitute Toggle Switch to Operate a Relay and Load)	
Connect a Motor Starter with a Start–Stop and a Jog Control Circuit Using a Control Relay	
Connect Two Forward and Two Reverse Control Stations with Push–button and Auxiliary Contact Interlock	
Dismantle a Three–Phase Line Starter, Identifying All Parts and State the Purpose of Each and Reassemble	
Speed Control of a DC Motor and Study of its Characteristics	
Connect a Diac–SCR Variable Speed DC Drive and Study its Characteristics	
Connect a Diac–Triac Variable Speed DC Drive and Study its Characteristics	
Study the Characteristics of Various Static Logic Control Elements and Connect Different Control Schemes Using These Schemes	
Open Laboratory	
Total Lab Hours	30

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part

foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:*** ***Identifies, organizes, plans, and allocates resources***

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:*** ***Works with others***

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. ***Information:*** ***Acquires and uses information***

1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. ***Systems:*** ***Understands complex inter-relationships***

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. ***Technology:*** ***Works with a variety of technologies***

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
   a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. Demonstrates ability to understand and perform multi-step computations
d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course-specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes

g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. *Seeing Things In the Mind's Eye: Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks
4. *Knowing How to Learn: Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. *Reasoning: Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
1. *Responsibility: Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules

d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   INT-A1 through INT-A7;
   INT-B1 through INT-B14;
   INT-C1 through INT-C36;
   INT-D1;
   INT-F1 through INT-F11;
   INT-G1 through INT-G4;
   INT-H1 through INT-H5; and,
   INT-H8.

MASTER Curriculum
INSTRUMENTATION
(Associate of Applied Science Degree Program)

		LEC	LAB	CR
FIRST QUARTER*				
MATH 191	College Algebra	5	0	5
ENGL 191	Composition and Rhetoric I	5	0	5
CIS 191	Computer Programming Fundamentals	3	6	5
DDF 191	Engineering Graphics I	1	6	3
		14	12	18
SECOND QUARTER*				
MATH 193	College Trigonometry	5	0	5
ENGL 195	Technical Communications	5	0	5
PHY 191	Mechanics	4	3	5
INT 101	DC Circuit Analysis	4	3	5
		18	6	20
THIRD QUARTER*				
MATH 195	Differential Calculus	5	0	5
PHY 192	Electricity and Magnetism	4	3	5
INT 102	AC Circuit Analysis I	4	3	5
INT 105	Electronic Devices	4	3	5
		17	9	20
FOURTH QUARTER*				
PHY 291	Fluids, Heat, Sound and Light	4	3	5
INT 103	AC Circuit Analysis II	4	3	5
INT 201	Digital Fundamentals	4	3	5
EMT 201	Electromechanical Devices	4	3	5
		16	12	20
FIFTH QUARTER*				
EMT 202	Control Systems	4	3	5
INT 203	Microcomputer Fundamentals	4	3	5
EMT 203	Programmable Controllers	3	3	4
EMT 253	Motor Controls	4	3	5
		15	12	19
SIXTH QUARTER*				
EMT 254	Introduction to Process Control (Technical Elective)	2	6	4
EMT 250	Control Systems II (Technical Elective)	4	3	5
EMT 251	Distributed Control Systems (Technical Elective)	3	3	4
PSY 191	Introductory Psychology (Social Science Elective)	5	0	5
		14	12	18
	Program Totals	94	63	115

Sixth Quarter

***Each quarter is 10 weeks in length.**

EMT 254

MASTER PROGRAM

Introduction to Process Control

COURSE SYLLABUS

Total lecture hours: 20 **Total lab hours: 60** **Credit hours: 4**

COURSE DESCRIPTION:

Emphasizes the knowledge and skills required to draw and interpret standard ISA drawings. Topics include: instrumentation symbols, loop identification, open–loop control, closed–loop control, single–loop control and multi–loop control.

PREREQUISITE: **Engineering Graphics I**

COREQUISITE: **Fluids, Heat, Sound, and Light**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Instrumentation symbols;
2. Loop identification;
3. Open–loop control;
4. Closed–loop control;
5. Single–loop control; and,
6. Multi–loop control.

REQUIRED COURSE MATERIALS:

Textbook: *Instrumentation*, by Kirk and Rimboi, Latest Edition

Lab Manual: *Instrumentation*, by Kirk and Rimboi, Latest Edition

Hand Tools/Quantity Required:
Hand Tools
Safety Glasses
Test Equipment
Calibration Equipment

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Instrumentation Symbols	2
Loop Identification	2
Test #1	
Open Loop	2
Test #2	
Closed Loop	2
Single Loop	2
Test #3	
Multi–loop	10
Total Lecture Hours	**20**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Draw a Level Control Loop	6
Draw a Flow Control Loop	6
Draw a Temperature Control Loop	6
Draw a Pressure Control Loop	6
Draw a Density Control Loop	6
Draw a Multi–Loop Control	30
Total Lab Hours	**60**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:*** *Identifies, organizes, plans, and allocates resources*

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:*** *Works with others*

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. ***Information:*** *Acquires and uses information*

1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. ***Systems:*** *Understands complex inter-relationships*

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. ***Technology:*** *Works with a variety of technologies*

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks

3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. Reading: Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. Writing: Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. *Arithmetic/Mathematics: Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. *Listening: Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. *Speaking: Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate

c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement

b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
c. Demonstrates ability to formulate and follow personal schedules
d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
a. Knows and demonstrates ability to distinguish between positive and negative behaviors
b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
INT-A1 through INT-A7;
INT-B1 through INT-B14;
INT-C1 through INT-C36;
INT-D1 through INT-D11;
INT-E1 through INT-E9;
INT-F1 through INT-F13;
INT-G1 through INT-G4;
INT-H1 through INT-H5; and,
INT-H8.

EMT 250

MASTER PROGRAM

Control Systems II

COURSE SYLLABUS

Total lecture hours: 40 **Total lab hours: 30** **Credit hours: 5**

COURSE DESCRIPTION:

Emphasizes skills in the area of electronic instrumentation and stresses the use of electronic techniques to control industrial processes. Topics include: control systems, control system design, control system construction, and control system test report of failure analysis.

PREREQUISITE: Control Systems

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Electronic sensing devices;
2. Electrical and industrial safety;
3. Auxiliary electrical devices and means; and,
4. Potentiometric devices.

REQUIRED COURSE MATERIALS:

Textbook: *Automated Process Control Electronic,* by Harrington, John, Latest Edition

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;

3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Safety	
Industrial Electronics	
Auxiliary Electrical Devices and Miscellaneous	
Sensors—Time Measurement	
Temperature Control—Bridge Networks	
Review and Midterm	
Pressure Flow	
Level	
Analytical Instruments and Controllers	
Radiation and Transmission	
Review and Final Exam	
Total Lecture Hours	**40**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Personal Protective Equipment	3
Review Solid State Power Supplies	3
Position Sensors - Strain Gauge	3
RTD	3
Bridge	3
Pressure Sensor	3
Float Switch	3
Digital Controller	3
Analog Controller	3
PID Controller	3
Total Lab Hours	**30**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies

required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. ***Resources:*** ***Identifies, organizes, plans, and allocates resources***

1. Allocates time to complete assigned tasks on schedule
2. Determines and allocates required materials and resources for meeting objectives
3. Evaluates skills, performance, and quality of work and provides feedback

B. ***Interpersonal:*** ***Works with others***

1. Participates as a member of the team, contributing to group effort
2. Provides individual assistance/direction to peers as requested
3. Determines and meets expectations
4. Exercises leadership qualities to effectively communicate ideas and make decisions.
5. Negotiates resources in order to accomplish objectives
6. Works well with all members of the class

C. ***Information:*** ***Acquires and uses information***

1. Acquires and evaluates information
2. Organizes and maintains information
3. Interprets and communicates information

D. ***Systems:*** ***Understands complex inter-relationships***

1. Understands and works well with social, organizational, and technological systems
2. Monitors and corrects performance of system during operation
3. Recommends modifications to system to improve performance

E. ***Technology:*** ***Works with a variety of technologies***

1. Chooses relevant procedures, tools, and equipment
2. Applies appropriate procedures and techniques to accomplish tasks
3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. Basic Skills: Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
   a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts
   b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
   c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
   d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
   e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials
2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
   a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
   b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
   c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
   d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
   e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments
3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*

a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. Demonstrates ability to understand and perform multi-step computations
d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation

d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
   a. Demonstrates ability to objectively assess personal strengths and weaknesses
   b. Demonstrates ability to set realistic short-term and long-term goals
   c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
   d. Demonstrates ability to identify potential pitfalls and take evasive actions
   e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
   f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
   g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
   a. Demonstrates ability to detect problem through observation, inquiry, or directive
   b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
   c. Demonstrates ability to generate alternatives or options for problem solution
   d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
   e. Demonstrates ability to initiate and effect solution
   f. Demonstrates ability to take responsibility for outcomes

g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals

b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules

d. Demonstrates ability to wisely use classroom time
e. *Demonstrates use of good study habits and skills*
f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors
   b. Demonstrates honesty and integrity in working with peers and supervisors
   c. Takes full responsibility for personal actions
   d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
   e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
   INT-A1 through INT-A7;
   INT-B1 through INT-B14;
   INT-C1 through INT-C36;
   INT-D1 through INT-D11;
   INT-E1 through INT-E7;
   INT-F1 through INT-F11;
   INT-G1 through INT-G4;
   INT-H1 through INT-H5; and,
   INT-H8.

EMT 251

MASTER PROGRAM

Distributed Control Systems

COURSE SYLLABUS

Total lecture hours: 30 **Total lab hours: 30** **Credit hours: 4**

COURSE DESCRIPTION:

Continues the study of the various applications of distributed control. This course in intended primarily as a survey source of distributed control verses an in–depth study of any single distributed control system. Topics include: historical perspective and systems, basic system wide orientation, sub–systems overview, and report generation.

PREREQUISITE: **Control Systems**

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in::

1. Historical perspective and systems;
2. Basic system–wide orientation;
3. Sub–systems overview; and,
4. Report generation.

REQUIRED COURSE MATERIALS:

Textbook: *Process Control Technician*, Latest Edition

Hand Tools/Quantity Required:

Tools	
Safety Glasses	1 pair
Classroom Supplies	1
Calculator	1

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture, video and demonstrations.

Laboratory: Laboratory will be a hands–on process.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Perform the manipulative skills of the craft as required to satisfactorily complete laboratory assignments;
2. Apply theory to laboratory assignments;
3. Satisfactorily perform on written, oral, and practical examinations;
4. Satisfactorily perform on outside assignments including writing assignments;
5. Contribute to class discussions;
6. Maintain attendance per current policy; and,
7. Follow all shop rules and safety regulations as stated in the laboratory manual.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Control Systems Feedback	3
Complex Variable Concepts, Diff. Equations	3
Laplace and Z Transforms	3
Signal Flow Graphics	3
Modeling Electrical and Mechanical Systems Overview	3
Stability of Contract Systems, Report Generation	3
Time Domain Analysis of Control Systems	3
Root–Locus Technique–LAN	3
Single Loop, WAN, Distribution Control System	3
Multi Loop	3
Total Lecture Hours	**30**

LAB OUTLINE:

Lab Topics	Contact Hrs.
Feedback Lab	4
Variable Concept Problem	4
Laplace Problem	4
Signal Flow Graph Lab	4
Model Electrical System	4
Stability Problem	4
Control System Exercise	4
LAN Lab	4
WAN Lab	4
Multi Loop lab	4
Total Lab Hours	**40**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

- *A. Resources: Identifies, organizes, plans, and allocates resources*
  1. Allocates time to complete assigned tasks on schedule
  2. Determines and allocates required materials and resources for meeting objectives
  3. Evaluates skills, performance, and quality of work and provides feedback
- *B. Interpersonal: Works with others*
  1. Participates as a member of the team, contributing to group effort
  2. Provides individual assistance/direction to peers as requested
  3. Determines and meets expectations
  4. Exercises leadership qualities to effectively communicate ideas and make decisions.
  5. Negotiates resources in order to accomplish objectives
  6. Works well with all members of the class
- *C. Information: Acquires and uses information*
  1. Acquires and evaluates information
  2. Organizes and maintains information
  3. Interprets and communicates information
- *D. Systems: Understands complex inter-relationships*
  1. Understands and works well with social, organizational, and technological systems
  2. Monitors and corrects performance of system during operation
  3. Recommends modifications to system to improve performance
- *E. Technology: Works with a variety of technologies*
  1. Chooses relevant procedures, tools, and equipment
  2. Applies appropriate procedures and techniques to accomplish tasks

3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks

1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*

a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study

c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)

d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner

e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*

a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning

b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.

c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered

d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner

e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
   a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
   b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
   c. Demonstrates ability to understand and perform multi-step computations
   d. Demonstrates ability to read, interpret, and use standard measuring devices
   e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
   f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
   g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines
4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed
5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate

c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
g. Demonstrates ability to take responsibility for presentations

B. Thinking Skills: Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*

a. Demonstrates ability to objectively assess personal strengths and weaknesses
b. Demonstrates ability to set realistic short-term and long-term goals
c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
d. Demonstrates ability to identify potential pitfalls and take evasive actions
e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
g. Demonstrates maturity in taking responsibility for decisions

2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*

a. Demonstrates ability to detect problem through observation, inquiry, or directive
b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
c. Demonstrates ability to generate alternatives or options for problem solution
d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution

e. Demonstrates ability to initiate and effect solution
f. Demonstrates ability to take responsibility for outcomes
g. Demonstrates ability to effectively problem solve in individual, team, or group situations

3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
   a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery
   b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
   c. Demonstrates ability to visually discriminate in gross and fine imagery
   d. Demonstrates ability to visualize abstractly
   e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits

5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty

1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*

a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
c. Demonstrates ability to focus on task at hand and work to completion
d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time
e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner
3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly
4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement

b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
c. Demonstrates ability to formulate and follow personal schedules
d. Demonstrates ability to wisely use classroom time
e. Demonstrates use of good study habits and skills
f. Demonstrates maturity to take responsibility for own actions

5. *Integrity/Honesty: Chooses ethical courses of action*
a. Knows and demonstrates ability to distinguish between positive and negative behaviors
b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

Appropriate Reference Materials:

1. MASTER Technical Modules:
INT-A1 through INT-A7;
INT-B1 through INT-B14;
INT-C1 through INT-C36;
INT-D1 through INT-D11;
INT-E1 through INT-E9;
INT-F1 through INT-F13;
INT-G1 through INT-G4; and
INT-H1 through INT-H8.

PSY 191

MASTER PROGRAM

Introductory Psychology

COURSE SYLLABUS

Total lecture hours: 50 **Total lab hours: 0** **Credit hours: 5**

COURSE DESCRIPTION:

Emphasizes the basics of psychology. Topics include: science of psychology; social environments; life stages; physiology and behavior; personality; emotions and motives; conflicts, stress, and anxiety; abnormal behavior; and perception, learning, and intelligence.

PREREQUISITE: NONE

COURSE OBJECTIVES:

After successful completion of this course, the students will be able to study, understand, and solve problems in:

1. Science of psychology;
2. Social environments;
3. Life stages;
4. Physiology and behavior;
5. Personality;
6. Emotions and motives;
7. Conflicts, stress, and anxiety;
8. Abnormal behavior; and,
9. Perception, learning, and intelligence.

REQUIRED COURSE MATERIALS:

Textbook: *Exploring Psychology,* Latest Edition

METHOD OF INSTRUCTION:

Lecture: Didactic presentations will include lecture and demonstrations.

Method of Evaluation: A student's grade will be based on multiple measures of performance. The assessment will measure development of independent critical thinking skills and will include evaluation of the student's ability to:

1. Satisfactorily perform on written, oral, and practical examinations;
2. Satisfactorily perform on outside assignments including writing assignments;
3. Contribute to class discussions; and,
4. Maintain attendance per current policy.

LECTURE OUTLINE:

Lecture Topics	Contact Hrs.
Science of Psychology	**10**
Definitions	
Define psychology	
History and Methods	
Identify the founders of the major schools of psychology	
Careers in Psychology	
Describe methods used in psychological research	
Identify career options in psychology	
Social Environments	**10**
Definitions	
Define social psychology and attitude	
Attitudes	
Differentiate between types of conformity to social norms	
Attribution Theory	
Relate attitudes, reputations, and stereotypes to personal perceptions	
Identify career options in psychology	
Attraction	
Describe factors that link attraction and liking	
Conformity, Compliance, Obedience, Altruism, and Individualism	
Describe how the attribution theory explains behavior and some of its errors	
Communications	
Identify the four main factors in the communication process	
Group Processes	
Differentiate between verbal and nonverbal communication	
Provide examples of the use of effective and ineffective communications	

Practice active listening and non–judgmental paraphrasing of statements	
Define personal space and tell how it affects behavior	
List factors in group effectiveness	
List stages of group performance	
Life Stages	**10**
Physical Development	
Identify stages of growth and development throughout life span	
Moral Development	
Identify theories of moral development	
Cognitive Development	
Identify theories of cognitive development	
Physiology and Behavior	**10**
Nervous and Endocrine Systems	
Define roles of the nervous and endocrine systems of behavior	
Altered States of Consciousness	
Identify altered states of consciousness	
Personality	**10**
Definitions	
Define personality	
Theories	
Match major theorists with their schools of psychology	
Careers in Psychology	
Describe methods used in psychological research	
Identify career options in psychology	—
Total Lecture Hours	**50**

COURSE OBJECTIVES: SCANS COMPETENCIES

The Secretary's Commission on Achieving Necessary Skills (SCANS), U.S. Department of Labor, has identified in its "AMERICA 2000 REPORT" that all students should develop a new set of competencies and foundation skills if they are to enjoy a productive, full and satisfying life. These are in addition to the Technical Workplace Competencies required by industry. SCANS is made up of five competencies and a three-part foundation of skills and personal qualities that are needed for solid job performance. All italicized headings in this section are direct quotations from "What Work Requires of Schools: A SCANS Report for America 2000."

The following activities will be performed by each student for successful completion of this course:

I. COMPETENCIES

A. *Resources: Identifies, organizes, plans, and allocates resources*
   1. Allocates time to complete assigned tasks on schedule
   2. Determines and allocates required materials and resources for meeting objectives
   3. Evaluates skills, performance, and quality of work and provides feedback

B. *Interpersonal: Works with others*
   1. Participates as a member of the team, contributing to group effort
   2. Provides individual assistance/direction to peers as requested
   3. Determines and meets expectations
   4. Exercises leadership qualities to effectively communicate ideas and make decisions.
   5. Negotiates resources in order to accomplish objectives
   6. Works well with all members of the class

C. *Information: Acquires and uses information*
   1. Acquires and evaluates information
   2. Organizes and maintains information
   3. Interprets and communicates information

D. *Systems: Understands complex inter-relationships*
   1. Understands and works well with social, organizational, and technological systems
   2. Monitors and corrects performance of system during operation
   3. Recommends modifications to system to improve performance

E. *Technology: Works with a variety of technologies*
   1. Chooses relevant procedures, tools, and equipment
   2. Applies appropriate procedures and techniques to accomplish tasks
   3. Identifies or solves problems to maintain equipment

II. FOUNDATION SKILLS

A. **Basic Skills:** Reads, writes, performs arithmetic and mathematical operations, listens and speaks
   1. ***Reading:*** *Locates, understands, and interprets written information in prose and in documents such as manuals, graphs, and schedules*
      a. Demonstrates basic reading skills including abilities to perceive main ideas, draw appropriate conclusions, detect a sequence, locate answers, find facts, and infer from written texts

b. Demonstrates course specific reading skills including abilities to read, interpret, and comprehend information from text and supplemental materials on a level to facilitate productive independent and group study
c. Demonstrates ability to read, interpret, and utilize information from course specific instruments (i.e., charts, diagrams, graphs, schematics, blueprints, flow charts, etc.)
d. Demonstrates ability to read, interpret, and follow schedules and procedural instructions in a timely and appropriate manner
e. Demonstrates ability to choose and use most appropriate reading method (skim, scan, or read for comprehension) for materials

2. ***Writing:*** *Communicates thoughts, ideas, information, and messages in writing; and creates documents such as letters, directions, manuals, reports, graphs, and flow charts*
a. Demonstrates basic writing skills including abilities to produce written documents which conform with accepted grammatical and communication standards required for effective daily functioning
b. Demonstrates effective written study skills including note taking, maintaining course specific journals, workbooks, manuals, etc.
c. Demonstrates technical writing skills in preparing outlines, summaries, time lines, flow charts, diagrams, etc. appropriate to materials covered
d. Demonstrates ability to complete all required writings in a timely, complete, and professional manner
e. Demonstrates competence in subject matter through the organization and presentation of answers to required written assessments

3. ***Arithmetic/Mathematics:*** *Perform basic computations and approaches practical problems by choosing appropriately from a variety of mathematical techniques*
a. Demonstrates proficiency in basic arithmetic functions including ability to add, subtract, multiply, and divide whole numbers, fractions, decimals, and percentages
b. Demonstrates ability to read, comprehend, and select appropriate math procedures to work basic math problems
c. Demonstrates ability to understand and perform multi-step computations

d. Demonstrates ability to read, interpret, and use standard measuring devices
e. Demonstrates ability to comprehend, retain, and utilize course specific measuring devices effectively
f. Demonstrates ability to understand, retain, and utilize higher mathematical formulas and functions required for course specific math performance
g. Demonstrates ability to appropriately transfer mathematical calculations and information from paper to machines

4. ***Listening:*** *Receives, attends to, interprets, and responds to verbal messages and other cues*
   a. Functions at minimal or above required hearing levels to receive, attend, interpret, and respond to verbal messages and instructions and to safely operate machinery
   b. Demonstrates ability to hear, comprehend, and appropriately follow directions
   c. Demonstrates auditory ability to hear, comprehend, and utilize verbal classroom as well as other auditory instruction
   d. Demonstrates ability to discriminate between essential and non-essential verbal information and react appropriately
   e. Demonstrates ability to focus and fine-tune listening skills to receive, interpret, and respond to various sounds
   f. Demonstrates ability and maturity to seek and receive additional individualized instruction as needed

5. ***Speaking:*** *Organizes ideas and communicates orally*
   a. Demonstrates appropriate listening and speaking skills in personal conversations
   b. Demonstrates ability to choose and organize appropriate words to effectively communicate
   c. Demonstrates ability to speak clearly and distinctly with appropriate volume, tone, and body language for situation
   d. Demonstrates ability to spontaneously organize and present appropriate answers and/or short presentations for classroom and /or assessment purposes
   e. Demonstrates ability to formulate, organize, and deliver major presentations to peers or groups
   f. Demonstrates ability to speak effectively in one-on-one, small group, or large group presentations
   g. Demonstrates ability to take responsibility for presentations

B. **Thinking Skills:** Thinks creatively, makes decisions, solves problems, visualizes, knows how to learn and reasons

1. ***Decision Making:*** *Specifies goals and constraints, generates alternatives, considers risks, and evaluates and chooses best alternative*
    a. Demonstrates ability to objectively assess personal strengths and weaknesses
    b. Demonstrates ability to set realistic short-term and long-term goals
    c. Demonstrates ability to recognize and distinguish between positive and negative alternatives
    d. Demonstrates ability to identify potential pitfalls and take evasive actions
    e. Demonstrates ability to objectively and responsibly evaluate alternatives by testing hypotheses and selecting most appropriate response
    f. Demonstrates ability to profit from negative evaluations or mistakes by reformulating, redirecting, reconstructing, or retesting alternatives
    g. Demonstrates maturity in taking responsibility for decisions
2. ***Problem Solving:*** *Recognizes problems and devises and implements plan of action*
    a. Demonstrates ability to detect problem through observation, inquiry, or directive
    b. Demonstrates ability to grasp appropriate overview and degree of seriousness of problem and to behave responsibly in situation
    c. Demonstrates ability to generate alternatives or options for problem solution
    d. Demonstrates ability to research options, assess and evaluate options, and determine appropriate and best solution
    e. Demonstrates ability to initiate and effect solution
    f. Demonstrates ability to take responsibility for outcomes
    g. Demonstrates ability to effectively problem solve in individual, team, or group situations
3. ***Seeing Things In the Mind's Eye:*** *Organizes, and processes symbols, pictures, graphs, objects, and other information*
    a. Functions at minimum or above required visual levels in order to see, interpret, attend and respond to visual imagery and meet safety requirements for necessary machinery

b. Demonstrates ability to read, interpret, and act upon signs, symbols, and other visual cues
c. Demonstrates ability to visually discriminate in gross and fine imagery
d. Demonstrates ability to visualize abstractly
e. Demonstrates ability to apply visual imagery to applied tasks

4. ***Knowing How to Learn:*** *Use efficient learning techniques to acquire and apply new knowledge and skills*
   a. Demonstrates mastery of basic reading, math, and language skills through application
   b. Demonstrates ability to translate abstract theory into practical application
   c. Demonstrates ability to incorporate and generalize new learning into a sequential learning process
   d. Demonstrates knowledge of good study skills and learning habits
5. ***Reasoning:*** *Discovers a rule or principle underlying the relationship between two or more objects and applies it when solving a problem*
   a. Demonstrates use of simple logic
   b. Demonstrates ability to distinguish relationships
   c. Demonstrates ability to determine and isolate factors in relationships
   d. Demonstrates and applies knowledge through practice
   e. Recognizes that attitudes, skills, and practice are essential to productivity
   f. Demonstrates ability to discriminate between positive and negative, and act accordingly

C. **Personal Qualities:** Displays responsibility, self-esteem, sociability, self-management, and integrity and honesty
1. ***Responsibility:*** *Exerts a high level of effort and perseveres towards goal attainment*
   a. Demonstrates ability to formulate realistic and useful short and long term goals and complete steps necessary to timely achieve goals
   b. Demonstrates ability to make adjustments, revisions, and changes to achieve goals in a cooperative and polite manner
   c. Demonstrates ability to focus on task at hand and work to completion
   d. Demonstrates good work ethics through regular attendance, adequate classroom preparations, and appropriate use of classroom time

e. Demonstrates maturity to take responsibility for actions
f. Demonstrates ability to cooperatively work in individual, team, and group situations in timely and effective manner

2. ***Self-Esteem:*** *Believes in own self-worth and maintains a positive view of self*
   a. Presents a positive attitude toward tasks
   b. Demonstrates ability to separate work and personal behaviors
   c. Actively participates in learning opportunities by sharing knowledge and skills with peers and instructors
   d. Demonstrates ability to accept personal strengths and weaknesses and builds on positive behaviors
   e. Demonstrates ability to accept and use constructive criticism
   f. Accepts positive reinforcement in an appropriate manner

3. ***Sociability:*** *Demonstrates understanding, friendliness, adaptability, empathy, and politeness in group settings*
   a. Demonstrates appropriate and acceptable social behaviors in interactions
   b. Demonstrates ability to work cooperatively in individual, team, or group situations
   c. Demonstrates active interest in peers by offering assistance, sharing resources, and sharing knowledge in a professional and acceptable manner
   d. Demonstrates professional work ethic by separating work and personal social behaviors and acting accordingly

4. ***Self-Management:*** *Assesses self accurately, sets personal goals, monitors progress, and exhibits self-control*
   a. Accepts personal strengths and weaknesses and uses the same for positive advancement
   b. Demonstrates ability to continuously set, assess, choose, and modify objectives as the situation demands in an appropriate manner
   c. Demonstrates ability to formulate and follow personal schedules
   d. Demonstrates ability to wisely use classroom time
   e. Demonstrates use of good study habits and skills
   f. Demonstrates maturity to take responsibility for own actions

5. ***Integrity/Honesty:*** *Chooses ethical courses of action*
   a. Knows and demonstrates ability to distinguish between positive and negative behaviors

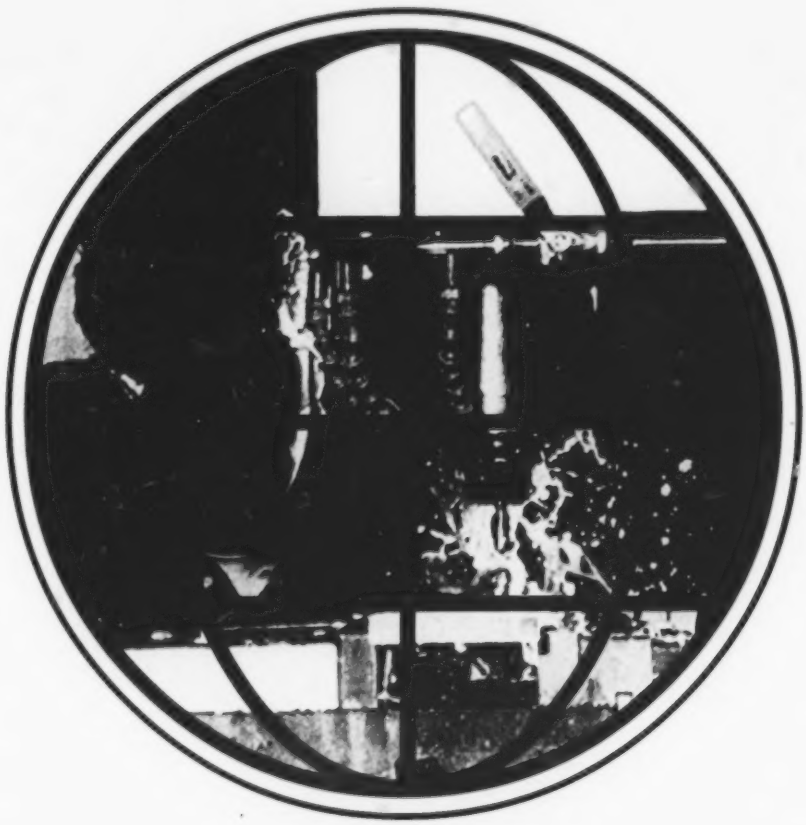
b. Demonstrates honesty and integrity in working with peers and supervisors
c. Takes full responsibility for personal actions
d. Demonstrates understanding of consequences for negative ethical behaviors and accepts responsibility for same when applicable
e. Demonstrates positive work and social ethics in undertakings

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

a consortium of educators and industry

EDUCATIONAL RESOURCES FOR THE MACHINE TOOL INDUSTRY



Instrumentation Series

INSTRUCTOR'S HANDBOOK
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Supported by the National Science Foundation's Advanced Technological Education Program

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

MASTER

EDUCATIONAL RESOURCES FOR THE MACHINE TOOL INDUSTRY

Instrumentation Series

INSTRUCTOR'S HANDBOOK

Supported by the National Science Foundation's Advanced Technological Education Program

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MASTER DEVELOPMENT CENTERS
Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES
AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES
Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

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SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

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Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

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Manufacturing in the Augusta Region

Augusta is the second largest city in Georgia and manufacturing represents the largest sector of the Augusta economy. The region is home to 810 manufacturers employing 89,717 people, an industrial base consisting of about 75% process control and 25% discrete parts production facilities. Major areas of emphasis for industry include technology transfer, factory floor training, and job certification programs. Growth of manufacturing in the region has been driven by Augusta's high tech development in electronics, process control, telecommunications, computers, medical services and instrumentation.

Augusta Technical Institute and Center for Advanced Technology (CADTEC)

Augusta Technical Institute (ATI) is part of Georgia's Department of Technical and Adult Education system, serving a large percentage of the two-state Central Savannah River area through its main campus and satellite facilities. The student body includes vocational-technical and college prep students, as well as current workers seeking retraining or skills upgrade; ATI has long emphasized outreach and special attention to the needs of low income, rural and disadvantaged residents, as well as displaced workers, single parents, women in non-traditional fields, and the disabled. In 1983, the Institute used the opportunity to host one of Georgia's new regional advanced technology centers (ATC's) to streamline its technical programs and thereby help to ensure the future employability of its students. ATI's Center for Advanced Technology (CADTEC) is designed to provide technology research and demonstration, industry assessments, technical consulting, and industry-specific contract training for the many established and emerging high tech companies in the Augusta region.

Development Team

- **Project Director:** Mr. Ray Center, Director of CADTEC, served as program director for the MASTER project.
- **Subject Matter Expert**: Ronnie Lambert, MS, MASTER Site Coordinator, had program responsibility for developing skill standards based on the industry skills verification process, as well as developing course curricula and program materials for the MASTER pilot program in Industrial Maintenance Mechanic and Instrumentation Technician. Mr. Lambert has taught Industrial Maintenance Mechanic and Instrumentation for 32 years in colleges and industry across the Southeast.

Introduction:
INSTRUCTOR'S HANDBOOK

Prior to the development of this Instructor's Handbook, **MASTER** project staff visited over 150 companies, conducted interviews with over 500 expert workers, and analyzed data from a national survey involving over 2800 participating companies. These investigations led to the development of a series of Instructor Handbooks, with each being fully industry-driven and specific to one of the technologies shown below.

Advanced CNC and CAM
Automated Equipment Repair
Computer Aided Design & Drafting
Conventional Machining
Industrial Maintenance
Instrumentation
LASER Machining
Manufacturing Technology
Mold Making
Tool And Die
Welding

Each Instructor's Handbook contains a collection of Technical Training Modules which are built around a Competency Profile for the specific occupation. **The Competency Profile which is the basis for this Instructor's Handbook, may be found on the following page (and on each of the tab pages of this book).**

Each Technical Training Module has been designed to be:

* Based on skill standards specified by industry. There must be a direct correlation between what industry needs and what is taught in the classroom and in the laboratory. For many years this type of training has been known as "competency-based training".

* Generic in nature. The training materials may then be customized by the trainer, for any given training situation based on the training need.

* Modular in design, to allow trainers to select lessons which are applicable to their training needs.

* Comprehensive, include training for advanced and emerging, highly-specialized manufacturing technologies.

* Self-contained, including all the components which might be needed by an experienced trainer. These components might include any or all of the following:
  - a standardized lesson plan,
  - an assessment instrument,
  - a listing of commercially available resources (e.g. recommended textbooks, instructor guides, student manuals, and videos),
  - new training materials, when suitable existing materials are not available (e.g., classroom handouts, transparency masters, and laboratory exercises).

This Instructor's Handbook is arranged by Duty groupings (Duty A, Duty B, etc.) with technical modules developed for each Task Box on the Competency Profile. Trainers are free to choose modules for a specific training need and combine modules to build individualized training programs.

This Instructor's Handbook is being offered with an accompanying Student Laboratory Manual for use by the students enrolled in the training program.

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and repair transmitters	C-12 Test different field sensing elements, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Calibrate transmitters	C-15 Tune controllers: pneumatic and electronic	C-16 Trouble-shoot and repair plant computing systems relating to process controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and repair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and configure smart field devices, i.e., transmitters and valves	C-35 Operate control systems including single element, cascade, ratio, and feedforward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Determine proper tools, equipment, and materials to perform the job	D-3 Coordinate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment isolation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write calibration procedures	D-8 Follow specifications and procedures	D-9 Perform algebraic operations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibration data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise procedures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Application of ISA/IIC standards	F-5 Understand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Understand personal computers	F-10 Attend on-going safety training courses	F-11 Participate in plant related training	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									

Duties ← **Tasks** →

Duties	Tasks												
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Troubleshoot, install, maintain, and operate motor starters	H-2 Troubleshoot, install, maintain, and operate relays	H-3 Troubleshoot, install, maintain, and operate pushbuttons	H-4 Troubleshoot, install, maintain, and operate switches	H-5 Troubleshoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Troubleshoot, install, maintain and operate PLCs					

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simu-late control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and re-pair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and re-pair transmit-ters	C-12 Test dif-ferent field sensing ele-ments, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Cali-brate trans-mitters	C-15 Tune controllers: pneumatic and electronic	C-16 Trouble-shoot and re-pair plant com-puting systems relating to pro-cess controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and re-pair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and con figure smart field devices, i.e., transmit-ters and valves	C-35 Operate control systems including single element, cas-cade, ratio, and feedforeward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Deter-mine proper tools, equip-ment, and ma-terials to per-form the job	D-3 Coordi-nate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment iso-lation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibra-tion proce-dures	D-8 Follow specifications and proce-dures	D-9 Perform algebraic op-erations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibra-tion data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise proce-dures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Applica-tion of ISA/IEC standards	F-5 Under-stand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Under-stand personal computers	F-10 Attend on-going safety training courses	F-11 Partici-pate in plant related train-ing	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-A1

Subject: **Instrumentation** **Time: 6 Hrs.**

Duty: **Practice Safety**
Task: Use Protective Equipment

Objective(s):

Upon completion of this module the student will be able to:

a. Identify safety equipment appropriate to protect the eyes from flying particulate matter or chemicals;
b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
c. Identify equipment appropriate to protect against high level of noise;
d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,
e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

Instructional Materials:

Overhead Projector;
Gloves
Safety Goggles
Dust Mask
Hearing Protection (ear plugs and ear muffs)
Face Shields
Handout Reading Assignments
MASTER Handout (INT-A1-HO)
Copy of 29 CFR 1910 Regulations
MASTER Laboratory Aid (INT-A1-LA)
MASTER Laboratory Worksheet (INT-A1-LW)
MASTER Self-Assessment

References:

Complete Text of OSHA Guidelines - 29 CFR 1910

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and *Loss Prevention Data,* Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston-Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Dubuque, IA, Kendall/Hunt Publishing Co., Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide); and *Practice for Industrial Lighting (ANSI A11.1-1965),* Illuminating Engineering Society, 345 East 47th St., New York, NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety; and *Loss Control,* International Labor Organization, 666 11th St. NW., Washington, DC 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and, *Standards and Recommended Practices;* National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

Air Purifying Respirators, - 30m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Personal Protection, - 20m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Using Respirators In Hazardous Environments, - 30m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Four Elements of Respiratory, - 11m - Video Tape, Latest Edition

Safety, Environmental Affairs Journal, - 33:08m - Video Tape - Coastal Video Communication, 3083 Brickhouse Court, Virginia Beach, VA 23452, Latest Edition

Protective Clothing, - 6:13m - Video Tape, Latest Edition

Hearing Protection Training, 1100 Series Ear Plugs, - 2m - Video Tape, Latest Edition

Lifting, Eye Protection and Hand Tool Safety, 20m - Video Tape - BBP, Latest Edition

Advanced Ind. Head Protection, - 20m - Video Tape, E.D. Bellard Co., Latest Edition

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Student Preparation:

All students must prepare themselves to enhance their attitudes toward safety. Such preparation may begin by the students asking themselves the following basic questions daily:

1. Is my hair properly stowed to prevent accidents?
2. Am I wearing any jewelry?
3. Do I have the proper shoes?
4. Do I have my eye shields (safety glasses)?
5. Is my work area free of debris and clean?
6. Does my machine have all its safeguards?
7. Is my machine working properly?
8. Do I know where the nearest fire extinguisher is?

Introduction:

Working safely should be the concern of every individual. Safety includes protecting yourself and others from injury. While others — your employer, your family, governmental agencies, and insurance companies — are concerned for your well-being, you have the final responsibility for your safety in the workplace. Being aware of your surrounding and selecting and using correct safety equipment is your responsibility.

Presentation Outline:

I. Describe Types of Conditions That Would Require the Use of Protective Equipment Due to Air Borne Partials
   - A. Grinding operations
   - B. Any time while in an active production environment
   - C. Near welding operations
   - D. Near high pressure water, air, or other medians, i.e., oil
   - E. Possibility of splashing chemicals

II. Identify Condition That Would Require the Use of a Hard Hat

A. Generally anytime while in a construction or manufacturing environment
B. In areas with low overhead clearances

III. Review Conditions That Would Require Use of Hearing Protection
A. Ear plugs
B. Ear muffs
C. OSHA requirements

IV. Describe Typical Conditions That Would Warrant Use of Gloves to Protect the Hands
A. Grinding
B. Working with rough metals
C. Working with multi strand steel cables
D. Electrical (special insulated gloves may be required for certain voltages)

V. Identify How Lungs Are Protected from Harmful Chemicals/Particles
A. Plant engineering/ventilation
B. Use of respirators or bubble suits
C. Review OSHA requirements for fiber glass, asbestos and chemical protection

Practical Application:

1. Instructor will demonstrate selection and proper use of safety equipment.
2. Students will be allowed to practice the use of safety equipment.

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objective as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-A2) dealing with accident prevention.

INT-A1-HO
Use Protective Equipment
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify safety equipment appropriate to protect the eyes from flying particle matter or chemicals;
b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
c. Identify equipment appropriate to protect against high level of noise;
d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,
e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

Reading Assignments:

The following chapters are assigned to read from *Supervisor's Safety Manual* textbook, Latest Edition:

Chapter	Title
7	Controlling Hazards; Protecting the Eyes: Equipment Types, Face Protection, Overcoming Employee Complaints; Protecting the Head: Fabrication, Auxiliary Features, Overcoming Objections; Ear Protection: Amount of Protection, Insert-Type Protectors, Muff Types; Protecting Fingers, Palms, and Hands; Protecting the Torso; Respiratory Protective Equipment: Selecting the Respirator, Overcoming Employee Complaints; Safety Belts and Harnesses: Fabrication, Lifelines, Inspection

and Care of Belts and Lines; Protection Against Ionizing Radiation: Monitoring Radiation; Safe Work Clothing: Materials for Protective Clothing; Clothing for Women, Special Problems Today for Men; "Selling" Personal Protective Equipment: Paying for Protective Equipment.

Module Outline:

I. Describe Types of Conditions That Would Require the Use of Protective Equipment Due to Air Borne Partials
   - A. Grinding operations
   - B. Any time while in an active production environment
   - C. Near welding operations
   - D. Near high pressure water, air, or other medians, i.e., oil
   - E. Possibility of splashing chemicals

II. Identify Condition That Would Require the Use of a Hard Hat
   - A. Generally anytime while in a construction or manufacturing environment
   - B. In areas with low overhead clearances

III. Review Conditions That Would Require Use of Hearing Protection
   - A. Ear plugs
   - B. Ear muffs
   - C. OSHA requirements

IV. Describe Typical Conditions That Would Warrant Use of Gloves to Protect the Hands
   - A. Grinding
   - B. Working with rough metals
   - C. Working with multi strand steel cables
   - D. Electrical (special insulated gloves may be required for certain voltages)

V. Identify How Lungs Are Protected from Harmful Chemicals/particles
   - A. Plant engineering/ventilation
   - B. Use of respirators or bubble suits
   - C. Review OSHA requirements for fiber glass, asbestos and chemical protection

INT-A1-LA
Use Protective Equipment
Attachment 2: **MASTER** Laboratory Aid

Standards of Performance Safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. There will be no horse play or practical joking; and,
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

INT-A1-LW
Use Protective Equipment
Attachment 3: **MASTER** Laboratory Worksheet

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1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Ear plugs
   Ear muffs

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercise inserting and removing ear plugs.

5. Practice using ear plugs.

6. Practice exercise using ear muffs.

Name_____ Date_____

INT-A1
Use Protective Equipment
Self-Assessment

1. What should not be worn around rotating or other movable-parts machinery?
_____

2. Name two types of devices which provide protection to the eye.
_____

_____

3. There are three types of coverings that provide protection from objects striking the head. Name two of them.
_____
_____

4. How do you determine if a pair of glasses are safety glasses?
_____

5. Of the two types of ear protection, which generally gives the best protection?
_____

6. What type of safety devices and apparel should be worn when you use solvents to clean parts or surfaces?
_____
_____

7. List all types of hearing protection.
_____
_____
_____

8. List all types of safety glasses.
_____
_____

9. What is purpose of eyewash equipment?

_____

_____

10. What is FDA?

_____

_____

INT-A1
Use Protective Equipment
Self-Assessment Answer Key

1. Loose clothing

2. a. Safety glasses
   b. Goggles

3. a. Hard hat
   b. Bump hat
   c. Skull hat

4. Manufacture's symbol on lens and frames

5. Ear muffs

6. Rubber or plastic covered gloves and apron plus safety glasses

7. Ear muffs, ear plugs

8. Goggles, safety glasses

9. Dilute toxic chemical in eye(s)

10. Food and Drug Administration

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-A2

Subject: Instrumentation **Time:** 4 Hrs.

Duty: Practice Safety
Task: Accident Prevention

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the two major factors in working safely;
b. List four steps you can take prior to performing work that will insure a safe outcome;
c. Identify the employee's responsibility if a potential accident or unsafe condition exists; and,
d. Select specific tasks that have the potential to cause an injury.

Instructional Materials:

Reading Assignment
MASTER Handout (INT-A2-HO)
Paper
Pencil
Chalkboard
Overhead Projector
MASTER Self-Assessment

References:

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and *Loss Prevention Data,* Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston - Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Dubuque, IA, Kendall/Hunt Publishing Co., Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide); and *Practice for Industrial Lighting (ANSI A11.1-1965),* Illuminating Engineering Society, 345 East 47th St., New York NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety; and *Loss Control,* International Labor Organization, 666 11th St. NW., Washington, DC 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and, *Standards and Recommended Practices,* National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

Hazard Communication Standard - Video Tape, Latest Edition

Supervisors Development Program - 10m - Video Tape - National Safety Council, Latest Edition

Behavioral Methods for Accident Prevention - 19m - Video Tape - Behavioral Science Technology, 323 East Matillia St, Suite 215, Ojai, CA 93023, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:
INT-A1 "Use Protective Equipment"

Introduction:

Accident prevention is the responsibility of management and every employee. You must continually be alert for potential or actual unsafe conditions. An attitude of safety will prevent injury, protect your job, and reduce operating costs for your employer. Relate the word accident to terms like broken back, blindness, and death to get it in perspective.

Presentation Outline:

I. Major Factors in Working Safely
   A. Knowing what the records are
   B. Recognizing when things are not as they should be

C. Attitude towards safety
    1. A state of mind that requires you to accept responsibility for your own and your co-workers safety
    2. A state of mind that does not compromise safety for production or speed
    3. A state of mind that would stop production rather than put an employee at unnecessary risk

II. Four Steps That Help Insure a Safe Job
    A. Preparing to do the job
        1. Research task to insure it can be performed
        2. Appropriate tools and help are available
        3. Proper lockout procedure
    B. Select appropriate safety equipment
    C. Once the job starts, maintain a clean work place
    D. Avoid unsafe practices
        1. Failing to use safety equipment
        2. Performing task you are not qualified to perform
        3. Rushing
        4. Practical joking
        5. Making do with a tool rather than getting the right tool

III. Employee Responsibility
    A. Assume responsibility for your own safety
    B. Notify crew and supervision of an unsafe condition
    C. Stop work if unsafe condition is identified

IV. Task That Have the Potential to Cause Injury
    A. Working with electricity
    B. Working near rotating equipment
    C. Working with chemicals and solvents
    D. Using pneumatic or hydraulic equipment
    E. Using ladders
    F. Lifting heavy objects
    G. Working in areas with harmful fumes

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objective as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-A3) dealing with working aloft.

INT-A2-HO
Accident Prevention
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the two major factors in working safely;
b. List four steps you can take prior to performing work that will insure a safe outcome;
c. Identify the employees responsibility if a potential accident or unsafe condition exist; and,
d. Select specific task that have the potential to cause an injury.

Reading Assignments:

The following chapters are assigned to read from ***Supervisor's Safety Manual*** textbook, Latest Edition:

Chapter	Title
4	Promote Safe Workmanship: Employee Committees, Safety Posters, Special-Purpose Reminders, Off-Beat Ideas, Recognition Organizations, Safety Meetings; Off-the-Job Accident Problems: Cost of Off-the-Job Accident Problems: Cost of Off-the-Job Accidents, Humanitarian Reasons for OTJ Safety Activities, Measuring Accident Experience, Integrating OTJ with On-the-Job Safety Programs, the Supervisor's Role in OTJ Safety.
5	Giving Instructions: Importance of Job Instruction, Starting the New Man; On-the-Job Training: Over-the-Shoulder Coaching; Job Safety Analysis: Select the Job, Break the Job Down, Identify Hazards and Potential Accidents, Develop Solutions, Benefits of JSA; Job Instruction Training: Step 1-Preparations, Step 2-Presentation, Step 3-Application, Step 4-Testing Follow-up; Other Methods of Instruction: The Lesson Plan, Programmed Instruction, Independent Study, Closed-Circuit TV, Summary.

FIRE PREVENTION CHECK LIST

ELECTRICAL EQUIPMENT

- ☐ No make shift wiring
- ☐ Extension cords serviceable
- ☐ Motors and tools free of dirt and grease
- ☐ Lights clear of combustible materials
- ☐ Safest cleaning solvents used
- ☐ Fuse and control boxes clean and closed
- ☐ Circuits properly fused
- ☐ Equipment approved for use in hazardous areas (if required)
- ☐ Ground connection clean and tight

FRICTION

- ☐ Machinery properly lubricated
- ☐ Machinery properly adjusted and aligned

SPECIAL FIRE-HAZARD MATERIALS

- ☐ Special isolation of flammable materials
- ☐ Nonmetal stock free of tramp metal

WELDING AND CUTTING

- ☐ Areas surveyed for fire safety
- ☐ Combustibles removed or covered
- ☐ Permit issued

OPEN FLAMES

- ☐ Kept away form spray rooms and booths
- ☐ Portable torches clear of flammable surfaces
- ☐ No gas leaks

PORTABLE HEATERS

- ☐ Set up with ample horizontal and overhead clearances
- ☐ Secured against tipping or upset
- ☐ Combustibles removed or covered
- ☐ Safely mounted on noncombustible surface
- ☐ Not used as rubbish burners

HOT SURFACES

- ☐ Hot pipes clear of combustible materials
- ☐ Ample clearance around boilers and furnaces
- ☐ Soldering irons kept off combustible surfaces
- ☐ Ashes in metal containers

SMOKING AND MATCHES

- ☐ "No smoking" and "smoking" areas clearly marked
- ☐ Butt containers available and serviceable
- ☐ No discarded smoking materials in prohibited areas

SPONTANEOUS IGNITION

- ☐ Flammable waste material in closed metal containers
- ☐ Flammable waste material containers emptied frequently
- ☐ Piled material cool, dry, and well ventilated
- ☐ Trash receptacles emptied daily

STATIC ELECTRICITY

- ☐ Flammable liquid dispensing vessels grounded or banded
- ☐ Moving machinery grounded
- ☐ Proper humidity maintained

HOUSEKEEPING

- ☐ No accumulations of rubbish
- ☐ Safe storage of flammables
- ☐ Passageways clear of obstacles
- ☐ Premises free of unnecessary combustible materials
- ☐ No leaks or dripping of flammables and floor free of spills
- ☐ Fire doors unblocked and operating freely with fusible links intact

EXTINGUISHING EQUIPMENT

- ☐ Proper type
- ☐ In proper location
- ☐ Unobstructed
- ☐ Clearly marked
- ☐ In working order
- ☐ Service date current
- ☐ Personnel trained in use of equipment

Module Outline:

I. Major Factors in Working Safely
   - A. Knowing what the records are
     1. Recognizing when things are not as they should be
   - B. Attitude towards safety
     1. A state of mind that requires you to accept responsibility for your own and your coworkers' safety
     2. A state of mind that does not compromise safety for production or speed
     3. A state of mind that would stop production rather than put an employee at unnecessary risk

II. Four Steps That Help Insure a Safe Job
   - A. Preparing to do the job
     1. Research task to insure it can be performed
     2. Appropriate tools and help are available
     3. Proper lockout procedure
   - B. Select appropriate safety equipment
   - C. Once the job starts, maintain a clean work place
   - D. Avoid unsafe practices
     1. Failing to use safety equipment
     2. Performing task you are not qualified to perform
     3. Rushing
     4. Practical joking
     5. Making do with a tool rather than getting the right tool

III. Employee Responsibility
   - A. Assure responsibility for your own safety
   - B. Notify crew and supervision of an unsafe condition
   - C. Stop work if unsafe condition is identified

IV. Task That Have the Potential to Cause Injury
   - A. Working with electricity
   - B. Working near rotating equipment
   - C. Working with chemicals and solvents
   - D. Using pneumatic or hydraulic equipment
   - E. Using ladders
   - F. Lifting heavy objects
   - G. Working in areas with harmful fumes

Name:_____ Date:_____

INT-A2
Accident Prevention
Self-Assessment

1. List two major factors in working safely.
   _____
   _____

2. List four steps that help insure a safe job.
   _____
   _____
   _____
   _____

3. Safety is _____ responsibility.

4. List four tasks that have the potential to cause injury.
   _____
   _____
   _____
   _____

5. One of the most important factors in personal safety is _____.

INT-A2
Accident Prevention
Self-Assessment Answer Key

1. Knowing what the hazards are and how to avoid them. Right attitude towards safety.

2. a. Be alert to unsafe condition
   b. Observe and recognize unsafe condition
   c. Decide how to handle situation safely
   d. Take necessary precaution to avoid injury

3. Your

4. a. Not right safety attitude
   b. Not obeying safety rules
   c. Not following safety procedure
   d. Not using PPE

5. Attitude

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-A3

Subject: Instrumentation **Time: 5 Hrs.**

Duty: Practice Safety
Task: Working Aloft

Objective(s):

Upon completion of this module the student will be able to:

a. Describe typical safety equipment used when working aloft;
b. Describe how to set up a portable ladder for use;
c. Define basic safety concerns while working from scaffolding;
d. Identify the safety concerns to be addressed while working from a personal man basket;
e. Demonstrate use of a safety belt/harness; and,
f. Demonstrate proper set up and use of a portable ladder.

Instructional Materials:

Safety Belt
Extension Ladder
Hard Hat (Instructor's Discretion)
Safety Glasses
MASTER Handout (INT-A3-HO)
MASTER Laboratory Aid (INT-A3-LA)
MASTER Laboratory Worksheet (INT-A3-LW)
MASTER Self-Assessment

References:

29 CFR 1910.25,26

29 CFR 1910.66

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; Loss Prevention Data, Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston -Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Dubuque, IA, Kendall/Hunt Publishing Co., Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide); and *Practice for Industrial Lighting (ANSI A11.1-1965)*, Illuminating Engineering Society, 345 East 47th St., New York, NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety; and *Loss Control*, International Labor Organization, 666 11th St. NW., Washington, D.C. 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and, *Standards and Recommended Practices*, National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

Ladder Safety, - 2:58m - Video Tape - Summit Training Source, Inc., 620 Three Mile Rd, N.W. Grand Rapids, MI 49504, Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

INT-A1 "Use Protective Equipment"
INT-A2 "Accident Prevention"

Introduction:

All maintenance technicians have to work aloft occasionally. This may be safely done if the technician is familiar with industry and OSHA regulations. An attitude of safety, the correct safety equipment, and proper training are all essential.

Presentation Outline:

I. Identify Safety Equipment Used When Working Aloft

Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA's rules

A. Equipment common to most personnel when working aloft
   1. Safety glasses
   2. Hard hat
   3. Safety belt or harness

II. Describe How to Set up a Portable Ladder for Use
   A. Portable ladder are broken down in the CFRs as metal and wood ladders
   B. Wood ladders see 29 CFR 1910.25
      1. Single section ladder
      2. Two section ladder
      3. Special use wood ladders
      4. Step ladder
   C. Metal ladders see 29 CFR 1910.26
   D. Set up 29 CFR 1910.26
      1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall for all sectional ladders

III. Basic Safety Concerns While Working from Scaffolding

Note: This module does not address scaffolding erection because special training is required

   A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
   B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
   C. Never lean over the handrails to perform work

IV. Concerns While Working from a Manlift or Personnel Lift (see 29 CFR 1910.68)
   A. Use basket or lift for employees and tools only, not freight
   B. If basket has integral test weights insure weights are removed prior to lifting personnel
   C. Hands must be inside basket while basket is moving
   D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
   E. Always inspect basket rigging prior to entry
   F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder
   A. Determine wall to base of ladder distance
   B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

Practical Application:

Students will practice in the lab. Each student will complete the **MASTER** Laboratory Worksheet (INT-A3-LW) and turn in to the instructor for checking.

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objective as a guide. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-A4) dealing with fire safety.

INT-A3-HO
Working Aloft
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe typical safety equipment used when working aloft;
b. Describe how to set up a portable ladder for use;
c. Define basic safety concerns while working from scaffolding;
d. Identify the safety concerns to be addressed while working from a personal man basket;
e. Demonstrate use of a safety belt/harness; and,
f. Demonstrate proper set up and use of a portable ladder.

Reading Assignments:

The following chapters are assigned to read from textbook:

Chapter	Title
9	Manual Handling Methods; Lifting and Carrying; Equipment for Handling; Hand Trucks, Ropes, Chains and Slings; Fiber Ropes; Rope Slings

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Module Outline:

I. Identify Safety Equipment Used When Working Aloft
Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA
   A. Equipment common to most personnel when working aloft
      1. Safety glasses
      2. Hard hat

3. Safety belt or harness

II. Describe How to Set up a Portable Ladder for Use
   A. Portable ladder are broken down in the CFRs as metal and wood ladders
   B. Wood ladders see 29 CFR 1910.25
      1. Single section ladder
      2. Two section ladder
      3. Special use wood ladders
      4. Step ladder
   C. Metal ladders see 29 CFR 1910.26
   D. Set up 29 CFR 1910.26
      1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall

III. Basic Safety Concerns While Working from Scaffolding

Note: This module does not address scaffolding erection because special training is required

   A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
   B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
   C. Never lean over the handrails to perform work

IV. Concerns While Working from a Man Basket or Personnel Lift
   A. Use basket or lift for employees and tools only, not freight
   B. If basket has integral test weights insure weights are removed prior to lifting personnel
   C. Hands must be inside basket while basket is moving
   D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
   E. Always inspect basket rigging prior to entry
   F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder
   A. Determine wall to base of ladder distance
   B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

INT-A3-LA
Working Aloft
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. If in doubt as to safe operation of the equipment, **STOP** and seek guidance from the instructor.

INT-A3-LW
Working Aloft
Attachment 3: **MASTER** Laboratory Worksheet

I. Identify Safety Equipment Used When Working Aloft
Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA
   A. Equipment common to most personnel when working aloft
      1. Safety glasses
      2. Hard hat
      3. Safety belt or harness

II. Describe How to Set up a Portable Ladder for Use
   A. Portable ladder are broken down in the CFRs as metal and wood ladders
   B. Wood ladders see 29 CFR 1910.25
      1. Single section ladder
      2. Two section ladder
      3. Special use wood ladders
      4. Step ladder
   C. Metal ladders see 29 CFR 1910.26
   D. Set up 29 CFR 1910.26
      1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall

III. Basic Safety Concerns While Working from Scaffolding
Note: This module does not address scaffolding erection because special training is required
   A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
   B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
   C. Never lean over the handrails to perform work

IV. Concerns While Working from a Man Basket or Personnel Lift
   A. Use basket or lift for employees and tools only, not freight
   B. If basket has integral test weights insure weights are removed prior to lifting personnel
   C. Hands must be inside basket while basket is moving
   D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
   E. Always inspect basket rigging prior to entry
   F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder
   A. Determine wall to base of ladder distance

B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

Name_____ Date_____

INT-A3
Working Aloft
Self-Assessment

1. A ladder with a 250 lb. weight capacity for heavy duty use is considered:
   a. Type IA
   b. Type I
   c. Type II
   d. Type III

2. An aluminum ladder can be used near electrical sources if it has rubber feet on the bottom.
   a. True
   b. False

3. How far must a ladder extend beyond the roof line if you are going to climb onto the structure?
   a. 1 foot
   b. 3 feet
   c. 10 feet
   d. None of the above

4. The base of a ladder should be placed so that it is one foot away from the structure for every four feet of height to the point where the ladder rests against the building?
   a. True
   b. False

5. A ladder whose top support points is 12 feet high should be how far from the structure?
   a. 2 feet
   b. 3 feet
   c. 4 feet
   d. None of the above

6. A step ladder can be leaned against a structure if it is secured at the bottom.
   a. True
   b. False

7. How often should a ladder be inspected?
   a. Once a month by maintenance personnel only
   b. Only if it has been dropped
   c. Before each use
   d. None of the above

INT-A3
Working Aloft
Self-Assessment Answer Key

1. b
2. b
3. b
4. a
5. b
6. a
7. c

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-A4

Subject: **Instrumentation** **Time: 4 Hrs.**

Duty: **Practice Safety**
Task: Fire Safety

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the technician's responsibilities relative to fire safety;
b. List conditions required for fire to exist;
c. Name four classes of fires;
d List four typical causes of industrial fires described in the lesson;
e. Match the correct class extinguishers to a given fuel source; and,
f. Demonstrate proper use of a fire extinguisher.

Instructional Materials:

Dust Mask
Gloves
Face Shields
Side Shields
Outside space appropriate for controlled fire
Adequate extinguishers to use for practice
Emergency extinguishers for correct class of the fire
MASTER Handout (INT-A4-HO)
Reading assignment in 29 CFR 1910.155 and 29 CFR 1910.157
MASTER Laboratory Aid (INT-A4-LA)
MASTER Laboratory Worksheet (INT-A4-LW)
MASTER Self-Assessment

References:

29 CFR 1910.155

29 CFR-1910.157

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and ***Loss Prevention Data,*** Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston-Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Kendall/Hunt Publishing Co., Dubuque, Iowa, Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide) and ***Practice for Industrial Lighting (ANSI A11.1-1965),*** Illuminating Engineering Society, 345 East 47th St., New York, NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety and ***Loss Control,*** International Labor Organization, 666 11th St. NW., Washington, DC 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and ***Standards and Recommended Practices,*** National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

Fire Fighting Equipment - 15m - Video Tape - (Akron), Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

INT-A1	"Use Protective Equipment"
INT-A2	"Accident Prevention"
INT-A3	"Working Aloft"

Introduction:

This module will provide you with the knowledge to prevent fires, and teach you how to react in the event of a fire and how to operate an extinguisher. It is not intended to make you a fire fighter. Each industry has its own procedure for handling fires and that procedure should become part of this module prior to teaching.

Working in Areas With Harmful Fumes:

In the operation of welding and cutting, toxic materials are given off in the form of smoke and other gases. Work areas in which this type of work is done must be well ventilated to prevent inhalation of toxic fumes and to prevent the possibility of oxygen deficiency. Certain metals, fluxes, and cleaning compounds are inhalation hazards. These include fluorine, lead, zinc, iron oxide, beryllium, cadmium, and mercury. If you doubt that ventilation is adequate, discontinue welding or cutting which involves these materials.

Presentation Outline:

I. Technician's Responsibility
   - A. Each employer will have company specific rules
   - B. Unless the technician is part of the company fire fighting crew or fire brigade
     1. Notify every one in the area to evacuate
     2. Get to a phone and notify appropriate department
     3. Something as simple as an ash tray or trash can can start fire that may be easily and safely extinguished. Appropriate department must be notified of the event
     4. Employees are responsible for keeping the workplace safe and for reporting unsafe conditions

II. Identify Conditions Required for a Fire to Exist
   - A. Fuel
   - B. Oxygen
   - C. Heat

III. Four Classes of Fire
   - A. Ordinary combustibles
   - B. Flammable liquids
   - C. Electrical
   - D. Combustible metals

IV. List Four Typical Causes of Workplace Fires
   - A. Careless smokers
   - B. Electrical overloads
   - C. Inadequate fire watch for welding and cutting operations
   - D. Combustible dust in the atmosphere

V. Demonstrate to Class How to Match the Correct Extinguishers for the Class of Fire

VI. Demonstrate Proper Use of a Fire Extinguisher

Practical Application:

Students will practice under instructor supervision using the correct extinguisher and extinguishing a fire. Each student will select, check, and use the appropriate extinguisher to put out a fire.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the readout (INT-A4-HO). Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-A5) dealing with lifting safety.

INT-A4-HO
Fire Safety
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the technicians responsibilities relative to fire safety;
b. List conditions required for fire to exist;
c. Name four classes of fires;
d. List four typical causes of industrial fires described in the lesson;
e. Match the correct class extinguishers to a given fuel source; and,
f. Demonstrate proper use of a fire extinguisher.

Reading Assignments:

The following chapters are assigned to read from textbook.

Chapter	Title
12	Basic Principles; Understanding Fire Chemistry; Determining Fire Hazards; Informing the Working Force; Causes of Fire: Electric Equipment, Friction; Special Fire-Hazard Materials; Welding and Cutting; Open Flames; Portable Heaters; Hot Surfaces; Smoking and Matches; Spontaneous Ignition; Static Electricity; Fire-Safe Housekeeping; Alarms; Equipment; Evacuation; Fire Alarms; What About Extinguishers?; Follow Up for Fire Safety; Fire Brigades; Special Fire Protection Problems

Module Outline:

I. Technician's Responsibility
   A. Each employer will have company specific rules
   B. Unless the technician is part of the company fire fighting crew or fire brigade
      1. Notify every one in the area to evacuate
      2. Get to a phone and notify appropriate department
      3. Something as simple as an ash tray or trash can can start fire that may be easily and safely extinguished. Appropriate department must be notified of the event
      4. Employees are responsible for keeping the workplace safe and for reporting unsafe conditions

II. Identify Conditions Required for a Fire to Exist
   A. Fuel
   B. Oxygen
   C. Heat

III. Four Classes of Fire
   A. Ordinary combustibles
   B. Flammable liquids
   C. Electrical
   D. Combustible metals

IV. List Four Typical Causes of Workplace Fires
   A. Careless smokers
   B. Electrical overloads
   C. Inadequate fire watch for welding and cutting operations
   D. Combustible dust in the atmosphere

V. Demonstrate to Class How to Match the Correct Extinguishers for the Class of Fire

VI. Demonstrate Proper Use of a Fire Extinguisher

Fire Extinguisher
Agent Characteristics

Suitable for use on what type of fire: B C

Agent Characteristics:
- Regular or Ordinary Dry Chemical
- Basically Sodium Bicarbonate
- Discharges a white cloud
- Leaves residue
- Non-freezing

Average Size - 1 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: ABC or BC

Agent Characteristics:
- Multipurpose Dry Chemical
- Basically Ammonium Phosphate
- Discharges a yellow cloud
- Leaves residue
- Non-freezing
- Some extinguishers utilizing this agent do not have an "A" rating; however, they are designated as having "A" capability.

Average Size - 2 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- Purple-K Dry Chemical
- Basically Potassium Bicarbonate
- Discharges a bluish cloud
- Leaves residue
- Non-freezing

Average Size - 2 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- KCL Dry Chemical
- Basically Potassium Chloride
- Discharges a white cloud
- Leaves residue
- Non-freezing
- Potassium Chloride/Urea

Average Size - 2 to 30 lbs. (11 to 23)
Horizontal Range - 5 to 20 ft. (15 to 30)
Discharge Time - 8 to 25 sec. (20 to 31)

Suitable for use on what type of fire: B C

Agent Characteristics:
- Carbon Dioxide
- Basically an inert gas that discharges a cold white cloud
- Leaves no residue
- Non-freezing

Average Size - 2 ½ to 20 lbs.
Horizontal Range - 3 to 8 ft.
Discharge Time - 8 to 30 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- Halogenated Agent
- Basically halogenated hydrocarbons
- Discharges a white vapor
- Leaves no residue
- Non-freezing

Average Size - 2 ½ lbs.
Horizontal Range - 4 to 8 ft.
Discharge Time - 8 to 10 sec.

Suitable for use on what type of fire: A

Agent Characteristics:
- Water
- Basically tap water
- Discharges in a solid or spray stream
- May contain corrosion inhibitor which leaves a yellow residue
- Protect from freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: A

Agent Characteristics:
- Anti-Freeze Solution
- Basically a Calcium Chloride solution to prevent freezing
- Discharges a solid or spray stream
- Leaves residue
- Non freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: A B

Agent Characteristics:
- Loaded Stream
- Basically an alkali-metal-salt solution to prevent freezing
- Discharges a solid or spray stream
- Leaves residue
- Non freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: B

Agent Characteristics:
- Foam
- Basically a water and detergent
- Discharges a foamy solution
- After evaporation, leaves a powder residue
- Protect from freezing

Average Size - 18 oz.
Horizontal Range - 10 to 15 ft.
Discharge Time - 24 sec.

Suitable for use on what type of fire: D

Agent Characteristics:
- Dry Powder Special Compound
- Basically Sodium Chloride or Graphite materials
- Agent is discharged from an extinguisher in a solid stream or is applied with a scoop or shovel to smother combustible metal
- Leaves residue
- Non-freezing

Average Size - 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 25 to 30 sec.

INT-A4-LA
Fire Safety
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. If in doubt as to safe operation of the equipment, **STOP** and seek guidance from the instructor.

INT-A4-LW
Fire Safety
Attachment 3: **MASTER** Laboratory Worksheet

Standard of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Worksheet:

1. Established standards for safety and conduct shall be followed

2. Equipment required:
   Dust Mask;
   Gloves;
   Fire extinguishers;
   Face shield; and,
   Side shields.

3. Instructor must confirm proficiency prior to student progressing

4. Practice exercises
   A. Instructor will demonstrate proper usage of fire extinguishers
   B. Student shall practice using fire extinguishers

Name_____ Date_____

INT-A4
Fire Safety
Self-Assessment

Answer the following questions by circling the correct answer.

1. Conditions required for a fire to exist:
   a. Fuel, Hydrogen, Heat
   b. Hydrogen, Oxygen, Fuel
   c. Heat, Hydrogen, Oxygen
   d. Fuel, Oxygen, Heat

2. Four classes of fire are:
   _____
   _____
   _____
   _____

3. List four typical causes of workplace fires:
   _____
   _____
   _____
   _____

4. A Class _____ fire extinguisher is used for electrical fires.

5. A Class _____ fire extinguisher is used for ordering combustibles fires.

INT-A4
Fire Safety
Self-Assessment Answer Key

1. b

2. Four classes of fire are:
   a
   b
   c
   d

3. List four typical causes of workplace fires:
   combustibles
   flammable liquids
   electrical equipment
   combustible metals

4. C

5. A

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-A5

Subject: Instrumentation **Time: 3 Hrs.**

Duty: Practice Safety
Task: Lifting Safety

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the consequences of improper lifting techniques;
b. Recognize when it is unsafe to lift an object alone;
c. Demonstrate proper lifting techniques;
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items;
e. State formula for dealing with center of gravity;
f. Identify parts of hoist;
g. Safely demonstrate using a hoist; and,
h. Move a load using a hoist.

Instructional Materials:

Large Empty Cardboard Box
Pencil
Paper
Gloves
Safety Glasses
Hand Truck
Conveyor
Chains
Sling
Face Shield
Side Shield
MASTER Handout (INT-A5-HO)
MASTER Laboratory Worksheet (INT-A5-LW)
MASTER Laboratory Aid (INT-A5-LA)
Copy of 29 CFR 1910 Regulations

References:

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and *Loss Prevention Data,* Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston-Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Kendall/Hunt Publishing Co., Dubuque, IA, Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide) and *Practice for Industrial Lighting (ANSI A11.1-1965),* Laminating Engineering Society , 345 East 47th St., New York, NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety and *Loss Control,* International Labor Organization, 666 11th St. NW., Washington, DC, 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and *Standards and Recommended Practices,* National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

Supervisor's Safety Manual, Latest Edition

Mechanics' and Millwrights' Guide, Carl Nelson, Audel Publishers, Latest Edition

Maintaining a Healthy Back, - 15m - Video Tape - Ergodyne Corp., Latest Edition

Lifting, Eye Protection and Hand Tool Safety, - 20m - Video Tape - BBP, Latest Edition

Rigging, - Video Tape - ITS - Video Tape, Latest Edition

Basic Injury Prevention, - C.L.M. - Video Tape, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

INT-A1	"Use Protective Equipment"
INT-A2	"Accident Prevention"
INT-A3	"Working Aloft"
INT-A4	"Fire Safety"

Introduction:

Injuries resulting from improper lifting probably are the number one cause of employee injury. A strong physically fit body is not enough to ensure you won't have back problems. Following time proven lifting methods and getting help when you need it is your best assurance. Remember you are responsible for your own safety. Furthermore, moving a load safely to protect the load, hoist, person operating the hoist, and other people is very important.

Presentation Outline:

I. Discuss the Importance of Lifting Safely
   - A. Give each student a copy of the following attachments:
     1. Laboratory Aid
     2. Objectives, Reading Assignments, and Module Outline
     3. Laboratory Worksheet

II. Identify the Steps to Manually Lift Safely
   - A. Estimate the load to be lifted. If it is heavier than one person should attempt, get help.
   - B. Place feet properly. Spread your feet slightly (comfortably), with one foot slightly ahead of the other and alongside the object.
   - C. Bend knees, kneel, or squat. Get close enough to the load to reach under it without bending the back.
   - D. Use blocking under objects to get a handhold and to prevent crushed fingers.
   - E. Get a good grip. Be sure you can maintain your grip on the object. Use gloves when handling sharp or rough objects.
   - F. Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting.
   - G. Do not turn the body at the waist while carrying a load.
   - H. Lower the load to the floor from the carrying position by bending the knees while keeping the back straight. This keeps the load on the leg and arm muscles. Keep fingers and toes clear as the load is set.

III. Consequences of Improper Lifting
   - A. Injury
   - B. Loss time

C. Possibility of becoming unemployed

IV. When Is It Unsafe to Lift an Object Alone
- A. Bulked load that restricts view
- B. When you would have to lift with your back rather than your legs
- C. When the object is too large to get a good grip

V. Discuss Handling Specific Shapes
- A. Locate center of gravity and use this area to lift
- B. Place as much weight as possible as close to lifting mechanism
- C. Place flat weight on button

VI. Safety Concerns When Lifting Rough, Sharp, or Fragile Objects
- A. Gloves
- B. Safety glasses
- C. Is the object being lifted a hazardous material?

VII. Discuss Equipment for Material Handling
- A. Hand trucks
- B. Powered trucks
- C. Conveyers
- D. Hoists

VIII. Discuss and Demonstrate Safe Use of Hand Trucks
- A. Place most of the weight on bed of hand truck
- B. May require two people if one object is difficult to lift on side
- C. Hold object tightly as handle is pulled back
- D. Adjust handle position so more weight is on hand end
- E. After movement, hold object tightly as handle is moved upward
- F. Lift object on one side so bed of truck can be moved away from object

IX. Discuss and Demonstrate Use of Powered Hand Trucks
- A. Watch out for people
- B. Drive unit slowly
- C. Use manual lifting rules

X. Discuss and Demonstrate Safe Use of Conveyers
- A. Watch for pinch points
- B. Exercise caution when loading and unloading objects
- C. Do not overload conveyers. Rollers may not move freely

XI. Discuss and Demonstrate Safe Use of Hoists
- A. Formula for dealing with center of gravity
- B. Identify parts of hoist
- C. Safely demonstrate using a hoist
- D. Identify types of loads
- E. Discuss and demonstrate lifting techniques
- F. Discuss and demonstrate moving techniques

XII. Discuss and Demonstrate Safe Use of Chains and Slings
- A. Storage area should be clean and dry
- B. Watch for pinch points
- C. Inspect for defects before using:
  - 1. Chains

a. Wear
b. Stretch
c. Distortion
d. Nicks
e. Cracks
f. Gauges

2. Slings
   a. Wear
   b. Stretch
   c. Distortion
   d. Flat, Sling Spots

D. Types
   1. Slings
      a. Choker
      b. Double Choker
      c. Bridle
      d. Basket
      e. Double Basket

Practical Application:

1. Basic laws of physics will be analyzed.
2. Physical characteristics of materials will be analyzed.
3. Students will practice correct lifting techniques.
4. Each student will then complete the Laboratory exercise where he will be graded on demonstrating proper lifting techniques.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the practical evaluation.

Summary:

Review the main lesson points using the Handout (INT-A5-HO) as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-A6) dealing with lockout/tagout.

INT-A5-HO
Lifting Safety
Attachment 1: **MASTER** Handout

Standards pf performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face-shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the consequences of improper lifting techniques;
b. Recognize when it is unsafe to lift an object alone;
c. Demonstrate proper lifting techniques;
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items;
e. State formula for dealing with center of gravity;
f. Identify parts of hoist;
g. Safely demonstrate using a hoist; and,
h. Move a load using a hoist.

Reading Assignments:

The following chapters are assigned to read from ***Supervisor's Safety Manual*** textbook, Latest Edition:

Chapter	Title
9	Material Handling Problems; Manual Handling Methods; Lifting and Carrying; Handling Specific Shapes; Equipment for Handling; Hand Trucks; Powered Hand Trucks; Powered Industrial Trucks; Conveyors; Chains and Slings

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide***, Carl Nelson, Audel Publishers, Latest Edition:

Chapter	Title
21	Rigging

Module Outline:

I. Discuss the Importance of Lifting Safely
   A. Give each student a copy of the following attachments:
      1. Laboratory Aid
      2. Objectives, Reading Assignments, and Module Outline
      3. Laboratory Worksheet
II. Identify the Steps to Manually Lift Safely
   A. Estimate the load to be lifted. If it is heavier than one person should attempt, get help.
   B. Place feet properly. Spread your feet slightly (comfortably), with one foot slightly ahead of the other and alongside the object.
   C. Bend knees, kneel, or squat. Get close enough to the load to reach under it without bending the back.
   D. Use blocking under objects to get a handhold and to prevent crushed fingers.
   E. Get a good grip. Be sure you can maintain your grip on the object. Use gloves when handling sharp or rough objects.
   F. Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting.
   G. Do not turn the body at the waist while carrying a load.
   H. Lower the load to the floor from the carrying position by bending the knees while keeping the back straight. This keeps the load on the leg and arm muscles. Keep fingers and toes clear as the load is set.
III. Consequences of Improper Lifting
   A. Injury
   B. Loss time
   C. Possibility of becoming unemployed
IV. When Is It Unsafe to Lift an Object Alone
   A. Bulked load that restricts view
   B. When you would have to lift with your back rather than your legs
   C. When the object is too large to get a good grip
V. Discuss Handling Specific Shapes
   A. Locate center of gravity and use this area to lift
   B. Place as much weight as possible as close to lifting mechanism
   C. Place flat weight on button
VI. Safety Concerns When Lifting Rough, Sharp, or Fragile Objects
   A. Gloves
   B. Safety glasses
   C. Is the object being lifted a hazardous material?
VII. Discuss Equipment for Material Handling

A. Hand trucks
B. Powered trucks
C. Conveyers
D. Hoists

VIII. Discuss and Demonstrate Safe Use of Hand Trucks
A. Place most of the weight on bed of hand truck
B. May require two people if one object is difficult to lift on side
C. Hold object tightly as handle is pulled back
D. Adjust handle position so more weight is on hand end
E. After movement, hold object tightly as handle is moved upward
F. Lift object on one side so bed of truck can be moved away from object

IX. Discuss and Demonstrate Use of Powered Hand Trucks
A. Watch out for people
B. Drive unit slowly
C. Use manual lifting rules

X. Discuss and Demonstrate Safe Use of Conveyers
A. Watch for pinch points
B. Exercise caution when loading and unloading objects
C. Do not overload conveyers. Rollers may not move freely

XI. Discuss and Demonstrate Safe Use of Hoists
A. Formula for dealing with center of gravity
B. Identify parts of hoist
C. Safely demonstrate using a hoist
D. Identify types of loads
E. Discuss and demonstrate lifting techniques
F. Discuss and demonstrate moving techniques

XII. Discuss and Demonstrate Safe Use of Chains and Slings
A. Storage area should be clean and dry
B. Watch for pinch points
C. Inspect for defects before using:
1. Chains
a. Wear
b. Stretch
c. Distortion
d. Nicks
e. Cracks
f. Gauges
2. Slings
a. Wear
b. Stretch
c. Distortion
d. Flat, Sling Spots
D. Types
1. Slings
a. Choker

b. Double Choker
c. Bridle
d. Basket
e. Double Basket

INT-A5-LA
Lifting Safety
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horseplay or practical joking.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, STOP and seek guidance from the instructor.

INT-A5-LW
Lifting Safety
Attachment 3: **MASTER** Laboratory Worksheet

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Worksheet:

1. Established standards for safety and conduct shall be followed.
2. Equipment required:
   Hand truck
   Conveyor
   Chains
   Sling
   Face shield
   Side shields
3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student's progressing to next exercise.
4. Practice manual lifting.
5. Practice using hand truck to carry objects.
6. Practice using powered truck to carry objects.
7. Practice using hoist to move objects.
8. Practice handling specific shapes.
9. Practice lifting with slings.
10. Practice lifting with chains.
11. Instructor will guide each exercise.
12. Instructor will grade each exercise.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-A6

Subject: Instrumentation **Time: 5 Hrs.**

Duty: Practice Safety
Task: Lockout/Tagout

Objective(s):

Upon completion of this module the student will be able to:

a. Recognize the benefits of an effective Lockout/Tagout procedure;
b. Identify who is allowed to remove or install a Lockout/Tagout tag or lock;
c. Recognize who is responsible for assuring equipment is properly locked out or tagged out prior to performing maintenance; and,
d. Determine if all emergency conditions are cleared for maintenance.

Instructional Materials:

Lock (Designed for Lockout)
Safety Tags
Lockout Hasp
Safety Switch
MASTER Handout (INT-A6-HO)
Relief Valve
Hydraulic Actuated Valve
Safety Sign (caution-lockout for safety before you start)
Valve Lockout
MASTER Self-Assessment
MASTER Laboratory Worksheet (INT-A6-LW)
MASTER Laboratory Aid (INT-A6-LA)
Copy of 29 CFR 1910.147 Regulations

References:

OSHA Lockout/Tagout Guidelines, 29 CFR 1910.147

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and ***Loss Prevention Data,*** Factory Mutual Engineering Corporation of the Factory

Mutual System, 1151 Boston-Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Kendall/Hunt Publishing Co., Dubuque, IA, Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide) and *Practice for Industrial Lighting (ANSI A11.1-1965)*, Illuminating Engineering Society, 345 East 47th St., New York NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety and *Loss Control*, International Labor Organization, 666 11th St. NW., Washington, DC 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and *Standards and Recommended Practices*, National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

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Student Preparation:

Students should have previously completed the following Technical Modules:

INT-A1	"Use Protective Equipment"
INT-A2	"Accident Prevention"
INT-A3	"Working Aloft"
INT-A4	"Fire Safety"
INT-A5	"Lifting Safety"

Introduction:

This module is designed to teach the purpose and importance of ensuring that the concepts of personal and group safety are not just concepts. Safety must be a way of life if work is to be performed without injury or loss. Think of Lockout/Tagout as life and health assurance. Lockout/Tagout procedures are required by OSHA.

Presentation Outline:

I. Benefits of an Effective Lockout/Tagout Program
   A. Reduced employee injuries and death
   B. Reduced down time
   C. Increased awareness of the employees' role in insuring safety in the work environment
   D. Less regulatory involvement
   E. Review 29 CFR 910.147

II. Who May Hang, Remove a Lockout or Tagout Tag or Lock
   A. Identify when a lockout is needed
   B. Identify when a tagout is appropriate. This will vary among industrial clearance procedures.

III. Responsibility for Lockout/Tagout
   A. Typically it is the work crew leader who is responsible for briefing the crew as to the clearance boundaries and what is locked out

IV. Locking out or Clearing a Piping, Mechanical System, or Component for Maintenance
   A. Identify typical sources of force that may be present in a typical piping system
      1. Static head pressure or induced thermal pressure
      2. In-line accumulators
      3. Non-insulated automatic actuating valves, motors, or relief
      4. System pressure
      5. Stress that any or all of these forces have the ability to injure or kill if not properly cleared and depressurized prior to maintenance
   B. Methods of relieving trapped pressure from a system or component
      1. Vent and drain valves
      2. Carefully loosen a flange and break the seal (never remove the bolts). Only loosen slightly.
      3. Open system relief valve
   C. Identify typical methods of disabling components prior to maintenance
      1. Manual valves
      2. Pneumatic valves (fail-open or closed)
      3. Hydraulic valves
      4. Relief valves
      5. Fans
      6. Rollers
   D. Energy sources can take many forms, including:
      1. Electrical
      2. Pneumatic
      3. Hydraulic
      4. Mechanical

5. Fluid and gas
6. Thermal
7. Pressurized water
8. Gravity

E. Accidental start-up or release of stored energy can sometimes be controlled with safety devices. Some examples are:
1. Machine guards
2. Electrical disconnects
3. Mechanical stops
4. Point-of-operation guards

Practical Application:

Students will practice correct lockout/tagout procedures. Each student will complete the laboratory exercise and will be graded on demonstrating proper lockout/tagout procedure.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluations.

Summary:

Review the main lesson points using the Handout (INT-A6-HO) as a guide for discussion and practice lockout/tagout procedures.

Next Lesson Assignment:

MASTER Technical Module (INT-A7) dealing with using electrical equipment.

Glossary:

Affected Employee

An employee whose job requires him/her to operate or use a machine or equipment on which service or maintenance is being performed under lockout/tagout, or whose job requires him/her to work in an area in which such service ir maintenance is being performed. Affected employees must be informed when lockout/tagout is being performed.

Authorized Employee

A person who locks and tags machines or equipment in order to perform service or maintenance on that machine or equipment.

Blanks

Typically, a metal disk that is inserted into the space between two pipe flanges. The blank is then bolted in place and forms a solid block to prevent the passage of liquids or gases through the pipe. "Blanking" (the insertion of blanks) is an important step to assure the safe entry into tanks or vessels if the materials in the pipes pose a hazard to employees working inside.

Bleed

Releasing stored hydraulic, electrical or pneumatic energy.

Block-Out

Physically preventing the movement of machinery or equipment using mechanical devices such as blocks, chains, cribbing or timbers.

Capable of Being Locked Out

An energy isolating device is capable of being out if it has a hasp or other means of attachment to which, or through which, a lock can be affixed, or it has a locking mechanism built into it. Other energy isolating devices are capable of being locked out if lockout can be achieved without the need to dismantle, rebuild or replace the energy isolating device or permanently alter its energy control capability.

Energized

Connected to an energy source or containing residual or stored energy.

Energy

All sources of power to a given piece of machinery or equipment. These can be electrical, pneumatic, hydraulic, process fluids and gases and mechanical.

Energy Control

The use of energy isolating devices to block or isolate energy sources, as well as Lockout/Tagout procedures to prevent unexpected start-up and release of stored energy during maintenance or installation.

Energy Isolating Device

A mechanical device that physically prevents the transmission or release of energy, including a manually operated electrical circuit breaker, a disconnect switch, a line valve, a block or any similar device used to block or isolate energy.

Energy Source

Any source of electrical, pneumatic, hydraulic, mechanical, thermal, chemical or other energy.

Lockout

The process used to identify, cut off and secure all energy sources before beginning repairs, adjustments or maintenance. A lockout device is used to secure equipment or machinery in the off position, ensuring that the equipment or machinery cannot be operated.

Lockout Device

A lock (either key or combination type) that holds an energy isolating device in a safe position and prevents the machine or equipment or machinery cannot be operated.

Normal Production Operations

The use of a machine or equipment to perform its intended production function.

Servicing and/or Maintenance

Workplace activities that require lockout/tagout on the equipment before beginning the activity because employees may be exposed to the unexpected energized or startup of the equipment or the release of hazardous energy. Servicing and/or maintenance includes constructing, installing, setting up, adjusting, inspecting, modifying, lubricating, cleaning and making tool changes.

Setting Up

Any work performed to prepare a machine or equipment to perform its normal production operation.

Tagout

Attaching a tag to the lock on the power source that has been shut off, indicating the time, reason for the lockout and the name of the person doing the work. The tag acts as a warning not to restore energy to the equipment or machinery.

Tagout Device

A prominent warning tag which can be surely fastened to an energy isolating device to indicate that the energy isolating device and the equipment being controlled may not be operated until the tagout device is removed.

Written Energy Control Program

This is the main requirement of the OSHA Standard. The written program provides details about:

1. The hazards of uncontrolled energy;
2. Energy control and lockout/tagout procedures in the workplace;
3. Employee training;
4. Inspections; and,
5. Complete records of all inspection and training that applies to energy control and lockout/tagout.

Zero Energy State

All energy has been controlled in machinery or equipment.

INT-A6-HO
Lockout/Tagout
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Recognize the benefits of an effective lockout/tagout procedure;
b. Identify who is allowed to remove or install a lockout/tagout tag or lock;
c. Recognize who is responsible for assuring equipment is properly locked out or tagged-out prior to performing maintenance; and,
d. Determine if all emergency condition are cleared for maintenance.

Module Outline:

I. Benefits of an Effective Lockout/Tagout Program
   A. Reduce employee injuries and death
   B. Reduce down time
   C. Increased awareness pf employees role in insuring safety in the work environment
   D. Less regulatory involvement
   E. Review 29 CFR 1910.147
II. Who May Hang, Remove a Lockout or Tagout Tag or Lock
   A. Identify when a lockout is needed
   B. Identify when a tagout is appropriate. This will also vary between industry clearance procedures.
III. Responsibility for Lockout/Tagout
   A. Typically it is the work crew leader who is also responsible for briefing the crew as to the clearance boundaries and what is locked out
   B. Carefully loosen a flange and break the seal (never remove the bolts). Only loosen slightly.

C. Open system relief valve

IV. Locking out or Clearing a Piping, Mechanical System or Component for Maintenance

A. Identify typical sources of force that may be present in a typical piping system
   1. Static head pressure or induced thermal pressure
   2. Incline accumulators
   3. Unisolated automatic actuating valves, motors or relief
   4. System pressure
   5. Stress that any or all of these forces have the ability to injure or kill is not properly cleared lockout and depressurized prior to maintenance

B. Methods of relieving trapped pressure from a system or component
   1. Vent and drain valves
   2. Carefully loosen a flange and break the seal (never remove the bolts). Only loosen slightly.
   3. Open system relief valve

C. Identify typical methods of disabling components prior to maintenance
   1. Manual operated valves
   2. Pneumatic operated valves (fail open or closed)
   3. Hydraulic actuated valve
   4. Relief valves
   5. Fans
   6. Rollers

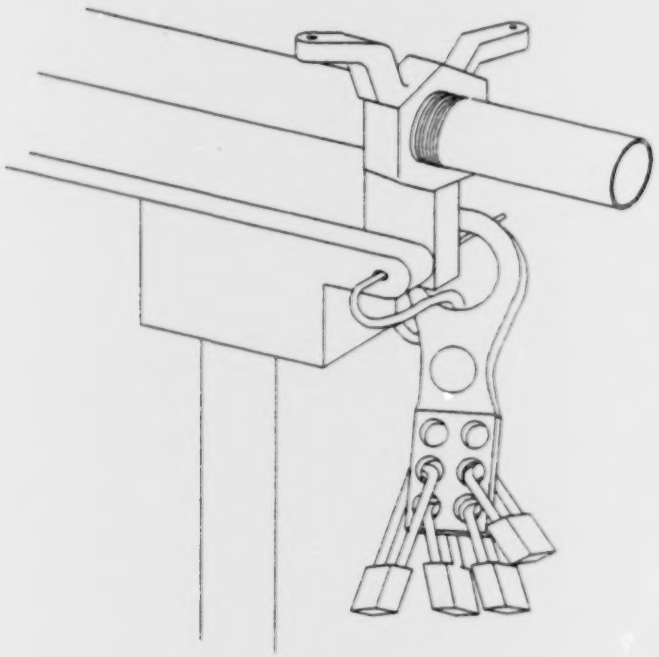
Reading Assignments:

Read the handout titled "Lockout and Tagout Procedures."

Lockout and Tagout Procedures

Lockout and tagout procedures are designed to prevent equipment from being energized while maintenance is taking place. The types and uses are defined by the Occupational Safety and Health Administration, CFR 1910.147.

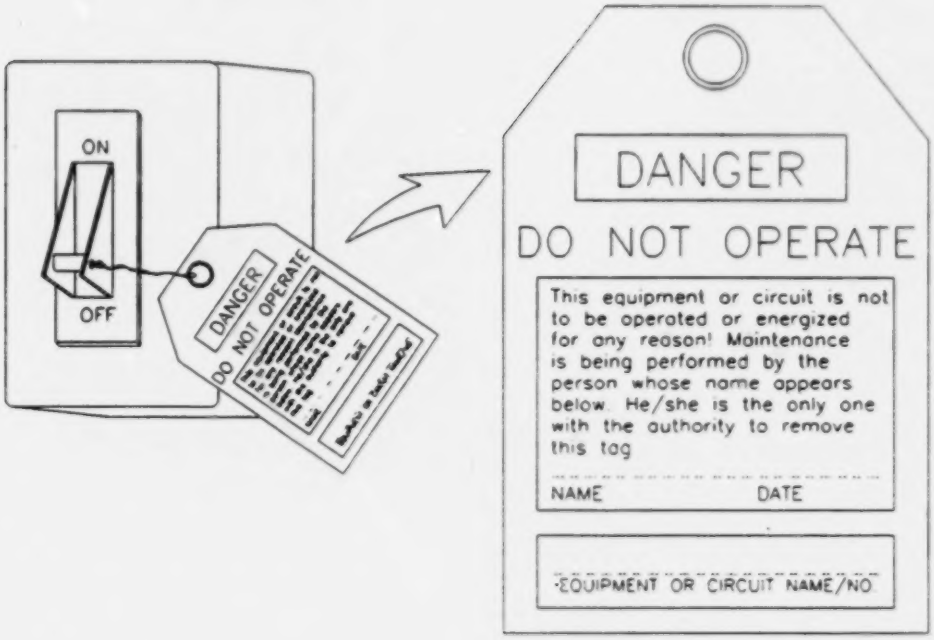
To lockout is to place a locking device on an energy-isolating device — a manually operated circuit breaker, for instance. The energy-isolating device and the equipment being controlled cannot be operated until the lockout device is removed. See Figure 1.



1 - A Lockout Device

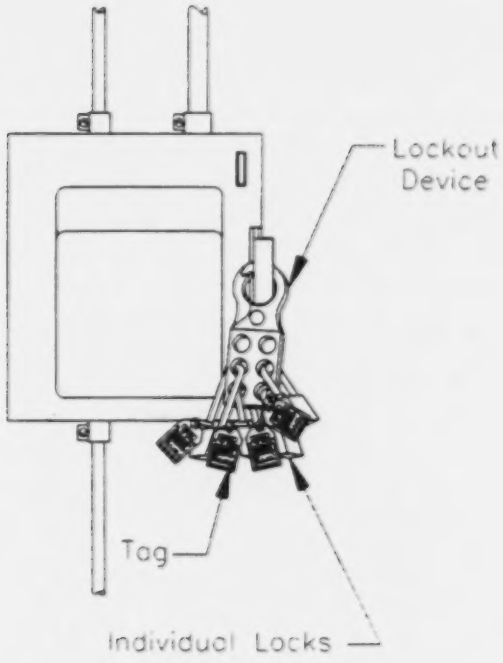
Remote or interlocking switches may not be used to control circuits. The use of emergency stops are prohibited for lockout-tagout by OSHA. They do not offer positive protection.

Tagouts are placed on an energy-isolating device. They indicate that the energy-isolating device and the equipment being controlled may not be operated. Tagouts are red and have black lettering. A tag must be signed and dated by the individual who placed it. OSHA has two additional requirements for these tags. The purpose of the lockout/tagout (the procedure performed) must be written on the tag. Most companies put this information on the back of a tag. See Figure 2.


ON
OFF
DANGER
DO NOT OPERATE
DANGER
DO NOT OPERATE
This equipment or circuit is not to be operated or energized for any reason! Maintenance is being performed by the person whose name appears below. He/she is the only one with the authority to remove this tag
NAME
DATE
EQUIPMENT OR CIRCUIT NAME/NO.

2 - Tagout

When more than one person is involved, each individual must place a lockout/tagout device on the isolation device. If a lockout device is used, it should be capable of accepting multiple locks. This is so each individual can place a lock on the device. Each lock should have a tag similar to the one used in the tagout procedure. The individual who puts the lock in place signs the tag. See Figure 3.



3 - Multiple-Lock Lockout Device

The lockout physically prohibits the operation of a piece of equipment. The tagout relies on those who read it. They must recognize its significance.

Wherever lockout/tagouts are used, there must be an established procedure for all to follow. All personnel must understand the importance and the use of the lockout/tagout system. The lockout/tagout devices used within an organization are standardized. So, anyone within the organization will recognize what they are.

The restrictions indicated by lockouts and tagouts remain in force until they are removed. The person putting the tagout or lockout in place is the person who has the authority to remove it.

The Occupational Safety and Health Act sets standards that are administered by the Occupational Safety and Health Administration (OSHA). OSHA has standard lockout/tagout procedures. The lockout/tagout procedures apply to all energy systems — air, hydraulic, mechanical, and electrical.

Zero-Energy Concept

Your job may be to maintain electrical circuits and equipment. However, many of them are connected to mechanical, hydraulic, or pneumatic devices. So, the equipment you work on may involve other types of energy in addition to electricity. Zero energy means all forms of energy are neutralized.

There may be hydraulic or pneumatic pressure in hoses or lines. There may be stored energy in weights or springs. There may be the potential for movement, as when air might blow through a turbine or fan. All these forms of energy must be recognized and neutralized. They have the potential to injure you or damage equipment.

Before working on any type of equipment, release or neutralize all energy which might affect that equipment. This means taking whatever action is necessary — turning a valve or putting a jack under a weight, for instance. This is the zero-energy concept.

INT-A6-LA
Lockout/Tagout
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-A6-LW
Lockout/Tagout
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. The project will require the student to demonstrate skills and knowledge in the following:
   A. Practice safety
   B. Use approved eye protection.
   C. Remove energy source
   D. Place tag
   E. Place lock
   F. Sign tag
   G. Remove lock
   H. Remove tag

2. Established standards for safety and conduct shall be followed.

3. Equipment required:
   A. Lock
   B. Tag
   C. Safety Switch

4. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

5. Practice exercises:
   A. Use lock to lock energy supply. Instructor must demonstrate placing lock on energy supply.
   B. Use tag to tag energy supply. Instructor must demonstrate placing tag on energy supply.

6. Practice exercise:
   A. Student shall practice placing tag on energy source.
   B. Student shall practice placing lock on energy source.

Name_____ Date_____

INT-A6
Lockout/Tagout
Self-Assessment

1. The term Lockout is best defined as:
   a. Blocking the flow of energy from a power source to a piece of equipment.
   b. Shutting down a piece of equipment for service or maintenance work.
   c. Applying a lock to a piece of equipment to show that it should not be used.
   d. Applying a tag to a piece of equipment to show that it should not be used.

2. A Lockout procedure is used whenever:
   a. The servicing or repair work to be done places an employee in danger.
   b. An equipment guard must be removed for servicing.
   c. A power source can be locked out for servicing.
   d. All of the above.

3. Tagout refers to :
   a. The warning tag attached to a power source or piece of machinery telling others not to restart.
   b. The process of blocking energy form reaching a piece of equipment.
   c. Signing off that a certain piece of machinery has been serviced.
   d. A device that physically prevents others from restarting equipment.

4. An authorized employee is one who:
   a. Works on machinery that is subject to lockout.
   b. Services machinery that is subject to lockout.
   c. Actually locks out equipment for servicing.
   d. Both b and c.

5. An affected employee is one who:
   a. Works on machinery that is subject to lockout.
   b. Works in an area where lockout is used.
   c. Services machinery that is subject to lockout.
   d. Both a and b.

6. Zero energy state refers to:
   a. A power source that is locked out for servicing.
   b. A power source that is locked out and tagged for servicing.
   c. The release of all stored energy from a power source.
   d. The release of all locks and tags so that energy can be restored.

7. It is all right to lend your lock to a co-worker if:
   a. The co-worker's lock is in another part of the building.
   b. The co-worker's lock is in another building miles away from where he is working.
   c. You know you won't be using your lock.
   d. None of the above.

8. If you come across a piece of equipment that is turned off but not locked out, you would:
   a. Ask someone working in the area if it could be turned back on.
   b. Notify someone who is authorized to perform lockout.
   c. Never restart the equipment.
   d. Both b and c.

9. A lockout audit must be performed by:
   a. An authorized person who works with the lockout procedure to be inspected,
   b. An authorized person who doesn't work with the lockout procedure to be inspected.
   c. A person from the Health and Safety department.
   d. None of the above.

10. Lockout/Tagout procedures are in place to:
   a. Prevent the accident start-up of equipment.
   b. Prevent workers from taking short-cuts while servicing equipment.
   c. To be used when startup occurs.
   d. To be used when the machine is stopped.

11. The _____ physically prohibits the operation of a piece of equipment.
   a. GFCI
   b. tagout device
   c. lockout device
   d. a, b, and c

12. The _____ does not physically prohibit operation of equipment; it relies on those who relies on those who read it.
   a. GFCI
   b. tagout device
   c. lockout device
   d. a, b, and c

13. Zero energy means all forms of energy (electrical, mechanical, fluid, and thermal) are neutralized.
   a. true
   b. false

14. Under normal operating conditions, in addition to you, who is allowed to remove your padlock form a machine's power source after a power lockout?
    a. no one
    b. The maintenance supervisor
    c. the safety engineer
    d. your supervisor

15. This organization establishes, implements, and enforces safe workplace guidelines.
    a. NEC
    b. ANSI
    c. OSHA
    d. NEMA
    e. UL
    f. UAW

INT-A6
Lockout/Tagout
Self-Assessment Answer Key

1. b
2. d
3. a
4. d
5. b
6. c
7. d
8. d
9. a
10. a
11. c
12. b
13. a
14. a
15. c

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-A7

Subject: **Instrumentation** **Time: 7 Hrs.**

Duty: **Practice Safety**
Task: Use Electrical Equipment

Objective(s):

Upon completion of this module the student will be able to:

a. State the difference in current levels of electrical shock and their effect on the body;
b. Compare electrical resistance between specified parts of the human body;
c. Summarize your company's policy for calibration and testing of meters and test equipment;
d. List five conditions of power or extension cords that make them unsafe for use;
e. Select the protective equipment you should use when working with operating electricity;
f. Explain the purpose and operation of a Ground Fault Circuit Interrupter (GFCI);
g. State the two factors which create an electrical-hazard situation;
h. State the purpose of the Occupational Safety and Health Act; and,
i. State your company's policy on the two-man rule.

Instructional Materials:

MASTER Handout (INT-A7-HO)
MASTER Laboratory Worksheet (INT-A7-LW)
Multimeter
Electrical Gloves
Paper
Pencil
MASTER Laboratory Aid (INT-A7-LA)
Copy of 29 CFR 1910 Regulations
Chalkboard
Overhead Projector
Multimeter
Resistors
Electrical Hand Tools
Wooden Ladder

References:

Complete Text of OSHA Guidelines- 29 CFR 1910

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and ***Loss Prevention Data,*** Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston-Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Kendall/Hunt Publishing Co., Dubuque, IA, Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide) and ***Practice for Industrial Lighting (ANSI A11.1-1965),*** Illuminating Engineering Society, 345 East 47th St., New York, NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety and ***Loss Control,*** International Labor Organization, 666 11th St. NW., Washington, DC 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and ***Standards and Recommended Practices,*** National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

Student Preparation:

Students should have previously completed the following Technical Modules:

INT-A1 "Use Protective Equipment"
INT-A2 "Accident Prevention"
INT-A3 "Working Aloft"

INT-A4 "Fire Safety"
INT-A5 "Lifting Safety"
INT-A6 "Lockout/Tagout"

Introduction:

When you work with electricity, safety is of prime concern. In this technical module, you will study electrical safety and electrical standards such as the National Electrical Code®. The National Electrical Code® and NEC® are registered trademarks of the National Fire Protection Association, Inc, Quincy, MA 62268.

Presentation Outline:

I. Electric Shock
   A. Voltage level
   B. Current level
   C. One hand rule
II. Electrical Resistance
   A. Body resistance
   B. Current path
   C. Ohm's Law
III. Electrical Test Meters
   A. Ohmmeter
   B. Voltmeter
   C. Ammeter
IV. Tools
   A. Ladders
   B. Electrical hand tools
   C. Tool condition
V. Protective Equipment
   A. Multimeter
   B. Electrical gloves
   C. Electrical hand tools
VI. Ground Fault Circuit Interrupter (GFCI)
   A. NEC requirements
   B. How GFCI works
   C. GFCI format
VII. Environmental
   A. Housekeeping
   B. Safety attitude
   C. Clean spills quickly
   D. Grounding
VIII. Occupational Safety and Health Act
   A. Purpose to OSHA

B. 29 CFR 1910

IX. Two Man Rule
   A. Buddy system
   B. Second person's responsibility

X. Guarding
   A. Safe distance from live circuits
   B. NEC 110-10, 240-41, 430-14, 511-7, 513-5, 514-4, 515-4, 516-7, 517
   C. 29 CFR 1910.331 through 29 CFR 1910.335

Practical Application:

Students will practice in the lab. Each student will complete the MASTER Laboratory Worksheet (INT-A7-LW) and turn in to the instructor for checking.

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the written and practical components.

Summary:

Review the main lesson points using the objectives as a guide. Hold class discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-B1) dealing with proper storage of circuit boards.

INT-A7-HO
Use Electrical Equipment
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safety knowledge when working with electrical devices by:
Observing all safety rules in lab;
Not touching an energized electrical circuit;
Exercising extreme caution in dealing with an electrical circuit; and,
Using electrically tested gloves and proper by calibrated test equipment when working with electricity.

Objectives:

Upon completion of this module the student will be able to:

a. State the differences in current levels of electrical shock and their effect on the body;
b. Compare electrical resistance between specified parts of the human body;
c. Explain safety benefits of good workplace housekeeping;
d. Summarize your company's policy for testing of meters;
e. Select the protective equipment you should use when working with operating electricity;
f. Explain the purpose and operation of a ground fault circuit interrupter (GFCI); and,
g. State the purpose of the Occupational Safety and Health Act.
h. State your company's policy on the two-man rule.

PHYSIOLOGICAL EFFECTS OF ELECTRIC CURRENTS		
Readings		**Effects**
Safe Current Values	1 mA or less	Causes no sensation - not felt.
	1 mA to 8 mA	Sensation of shock, not painful. Individual can let go at will since muscular control is not lost
Unsafe Current Values	8 to 15 mA	Painful shock - individual can let go at will since muscular control is not lost.
	15 to 20 mA	Painful shock - control of adjacent muscles lost. Victim cannot let go.
	20 to 50 mA	Painful, severe muscular contractions. Breathing difficult.
	50 to 100 mA	Ventricular fibrillation - a heart condition that can result in instant death - is *possible*.
	100 to 200 mA	Ventricular fibrillation occurs.
	200 mA and over	Severe burns, severe muscular contractions - so severe that chest muscles clamp the heart and stop it for the duration of the shock.

HUMAN RESISTANCE TO ELECTRICAL CURRENT	
	Resistance (Ohms)
Dry skin	100,000 to 600,000
Wet skin	1,000
Internal body - hand to foot	400 to 600
Ear to ear	100

Reading Assignments:

The following chapters are assigned to read from the *National Electrical Code* (NEC), NFPA 70, Batterymarch Park, Quincy, MA 02269:

Chapter	Title
1	Introduction, General
2	Wiring and Protection
3	Wiring Methods & Materials
4	Equipment for General Use
5	Special Occupancies
6	Special Equipment
7	Special Conditions
8	Communications Systems

Note: Above reading assignments in the NEC should translate into familiarity with the NEC.

The following chapters are assigned to read from *Supervisor's Safety Manual* textbook, Latest Edition:

Chapter	Title
2	See and Know Job Hazards
	Systematic Inspection
	Unsafe Conditions and Unsafe Acts

Module Outline:

I. Electric Shock
   - A. Voltage level
   - B. Current level
   - C. One hand rule

II. Electrical Resistance
   - A. Body resistance
   - B. Current path
   - C. Ohm's Law

III. Electrical Test Meters
   - A. Ohmmeter
   - B. Voltmeter
   - C. Ammeter

IV. Tools
   - A. Ladders
   - B. Electrical hand tools
   - C. Tool condition

V. Protective Equipment
   A. Multimeter
   B. Electrical gloves
   C. Electrical hand tools
VI. Ground Fault Circuit Interrupter (GFCI)
   A. NEC requirements
   B. How GFCI works
   C. GFCI format
VII. Environmental
   A. Housekeeping
   B. Safety attitude
   C. Clean spills quickly
   D. Grounding
VIII. Occupational Safety and Health Act
   A. Purpose to OSHA
   B. 29 CFR 1910
IX. Two Man Rule
   A. Buddy system
   B. Second person's responsibility
X. Guarding
   A. Safe distance from live circuits
   B. NEC 110-10, 240-41, 430-14, 511-7, 513-5, 514-4, 515-4, 516-7, 517
   C. 29 CFR 1910.331 through 29 CFR 1910.335

Standards of performance safety:

Student shall demonstrate safety knowledge when working with electrical devices by:
Observing all safety rules in lab;
Not touching an energized electrical circuit;
Exercising extreme caution in dealing with an electrical circuit; and,
Using electrically tested gloves and proper by calibrated test equipment when working with electricity.

INT-A7-LW
Use Electrical Equipment
Attachment 3: **MASTER** Laboratory Worksheet

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1. Practice using ohmmeter to measure resistors. Instructor will finish ohmmeter and resistors. Calibrate meter before using.

2. Practice using voltmeter to measure voltages. Instructor will furnish voltmeter. Calibrate meter before using.

3. Practice using ammeter to measure current. Calibrate meter before using.

4. Instructor will demonstrate proper use of electrical hand tools and electrical gloves.

5. Instructor will discuss ladders and electricity.

6. Instructor will demonstrate safety harness usage.

7. Instructor will discuss GFCI's.

8. Instructor will discuss housekeeping, safety attitude, and grounding, electric shock, OSHA, buddy system, and proper clearance from live circuits.

9. Instructor will discuss extension cord inspection and usage.

Name_____ Date_____

INT-A7
Use Electrical Equipment
Self-Assessment

1. A/an _____ is sensitive to very low levels of current leakage to ground.
   A. Ground-fault interrupter.
   B. Magnetic breaker.
   C. Thermal breaker.
   D. Adjustable inductor.

2. A ground fault outlet is designed to trip at:
   A. An overload of 16 to 21 Amps.
   B. Any fault current.
   C. Any over current.
   D. A fault current from 4 Milliamps to 6 Milliamps.

3. **Painful shock begins at 8 mA and muscle control is lost at 15 mA**. For a person with dry, uninjured skin, body resistance may be 8,000 ohms. If current enters through one hand and leaves through the other hand at 120 volts, using Ohms law, indicate below whether muscle control will be lost.
   A. Yes! Current is 15 Ma.
   B. Yes! Current exceeds 20 Ma
   C. No! Current is 10 Ma.
   D. No!. Current is 6 Ma.

4. Before checking for a shorted or grounded circuit, one should:
   A. Turn off all power to unit.
   B. Replace all fuses.
   C. Connect the ohmmeter in series with the load.
   D. All the above.

5. If it is necessary to test a live electrical circuit, you should:
   A. Use only one hand.
   B. Turn power off to connect test leads if possible.
   C. Test your meter on a known source of power.
   D. A, B and C.
   E. B. and C. Only.

6. Voltage that will cause involuntary freezing or lockup of body muscles is:
   A. 110 V
   B. 220 V
   C. 480 V
   D. 1000 V or more

7. The _____ physically prohibits the operation of a piece of equipment.
   A. GFCI
   B. Tagout device
   C. Lockout device
   D. A, B, and C.

8. The _____ does not physically prohibit operation of equipment; it relies on those who read it.
   A. GFCI
   B. Tagout device
   C. Lockout device
   D. A, B, and C

9. Zero energy means all forms of energy (electrical, mechanical, fluid, and thermal) are neutralized.
   A. True
   B. False

10. When is it safe to work on a suspended load?
   A. Never.
   B. When the part being fixed is on the bottom.
   C. When your supervisor says no.
   D. After the hoist or chain has been inspected.

11. Personal protective equipment is special equipment:
   A. To be used at your discretion.
   B. That prevents accidents.
   C. Purchased by the employee.
   D. That you must wear in dangerous situations.

12. A noise level between _____ decibels is most dangerous because it is not painful to the normal ear.
   A. 70-90
   B. 90-130
   C. 130-140
   D. 140-160

13. In double insulated tools, protection against electric shock is provided by the:
    A. Two-wire supply cord
    B. Three-wire supply cord
    C. Insulated case or liner
    D. Grounding lug

14. The lug on the adapter for a three-prong plug:
    A. Eliminates sparks
    B. Completes the grounding circuit
    C. Replaces the GFCI
    D. Increases the line to line resistance

15. The green grounding wire on electric tools:
    A. Is not grounded to the tool.
    B. Completes the electrical circuit.
    C. Is a part of the switch circuit.
    D. Connects to the tool's metal frame.

16. Which of the following kinds of ladders should you AVOID using around electrical equipment?
    A. Extension
    B. Step
    C. Metal
    D. Wooden

17. Which of the following does *NOT* carry current during normal operation of a circuit?
    A. Grounded wire
    B. Grounding wire
    C. Natural grey wire
    D. White wire

18. Under normal operating conditions, in addition to you, who is allowed to remove your padlock from a machine's power source after a power lockout?
    A. No one
    B. The maintenance supervisor
    C. The safety engineer
    D. Your supervisor

19. An electrical shock victim is frozen to the source of the shock; the ***FIRST*** thing you should do is:
    A. Pull the person away from the conductor
    B. Send for medical assistance
    C. Begin CPR
    D. Shut off the electricity
    E. Go for help
    F. Shout for help

20. When working near an exposed energized part (busbar, conductor, etc...) in the voltage range of 300V, up to 750V; the **minimum** approach distance for any conductive object is:
    A. Avoid contact
    B. 1 ft. 0 inches
    C. 1 ft. 6 inches
    D. 2 ft. 0 inches

INT-A7
Use Electrical Equipment
Self-Assessment Answer Key

1. A
2. D
3. A
4. A
5. D
6. A
7. B
8. B
9. A
10. A
11. D
12. A
13. C
14. B
15. D
16. C
17. B
18. A
19. D
20. A

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simu-late control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and re-pair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and re-pair transmit-ters	C-12 Test dif-ferent field sensing ele-ments, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Cali-brate trans-mitters	C-15 Tune controllers: pneumatic and electronic	C-16 Trouble-shoot and re-pair plant com-puting systems relating to pro-cess controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and re-pair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and con figure smart field devices, i.e., transmit-ters and valves	C-35 Operate control systems including single element, cas-cade, ratio, and feedforeward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Deter-mine proper tools, equip-ment, and ma-terials to per-form the job	D-3 Coordi-nate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment iso-lation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibra-tion proce-dures	D-8 Follow specifications and proce-dures	D-9 Perform algebraic op-erations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibra-tion data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise proce-dures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Applica-tion of ISA/IIC standards	F-5 Under-stand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Under-stand personal computers	F-10 Attend on-going safety training courses	F-11 Partici-pate in plant related train-ing	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-B1

Subject: Instrumentation **Time:** 2 Hrs.

Duty: Maintain Control Systems
Task: Proper Storage of Circuit Boards

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate proper storage of circuit boards;
b. Demonstrate proper handling of circuit boards;
c. Use anti-static bags to shield printed circuit boards;
d. Exercise caution when handling a thermally hot printed circuit board; and,
e. Exercise caution when handling an electrically hot printed circuit board.

Instructional Materials:

Circuit Boards
Static Shielding Bag
MASTER Handout (INT-B1-HO)
MASTER Laboratory Aid (INT-B1-LA)
MASTER Laboratory Worksheet (INT-B1-LW)

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-A7 "Use Electrical Equipment"

Introduction:

Printed circuit boards allow solid state electronic devices a place to reside. The platform may be single or multilayered. Usually the electronic devices are soldered to the circuit board. Sometimes the electronic devices are mounted into a socket which is soldered to the circuit board. Many instrumentation devices are electronic and use circuit boards to house the electronic devices. Proper handling and storage becomes very important in order to maintain system and component integrity and provide and safe and functional operating system.

Presentation Outline:

I. Purpose of Printed Circuit Boards
II. Composition of Printed Circuit Boards
III. Wire used on Printed Circuit Boards
IV. Terminals used with Printed Circuit Boards
V. Layout of Printed Circuit Boards
VI. Thermal Considerations of Printed Circuit Boards
VII. Electrical Voltage on Printed Circuit Boards
VIII. Shielded Bag for Printed Circuit Board Protection

Practical Application:

1. Instructor will demonstrate proper handling of circuit boards.

2. Student will demonstrate proper handling of circuit boards.

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-B2) dealing with collecting and recording data according to company requirements.

INT-B1-HO
Proper Storage of Circuit Boards
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate proper storage of circuit boards;
b. Demonstrate proper handling of circuit boards;
c. Use anti-static bags to shield printed circuit boards;
d. Exercise caution when handling a thermally hot printed circuit board; and,
e. Exercise caution when handling an electrically hot printed circuit board.

Module Outline:

I. Purpose of Printed Circuit Boards
II. Composition of Printed Circuit Boards
III. Wire used on Printed Circuit Boards
IV. Terminals used with Printed Circuit Boards
V. Layout of Printed Circuit Boards
VI. Thermal Considerations of Printed Circuit Boards
VII. Electrical Voltage on Printed Circuit Boards
VIII. Shielded Bag for Printed Circuit Board Protection

INT-B1-LA
Proper Storage of Circuit Boards
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B1-LW
Proper Storage of Circuit Boards
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

Instructor will demonstrate:
a. Proper handling of circuit boards; and,
b. Proper storage of circuit boards.

Student will demonstrate:
a. Proper handling of circuit boards; and,
b. Proper storage of circuit boards.

Instructor will grade student on:
a. Proper handling of circuit boards; and,
b. Proper storage of circuit boards.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-B2

Subject: **Instrumentation** **Time: 3 Hrs.**

Duty: **Maintain Control Systems**
Task: Collect and Record Data According to Company Requirements

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate collecting data according company requirements; and,
b. Demonstrate recording data according to company requirements.

Instructional Materials:

P&ID diagrams
Technical manuals
MASTER Handout (INT-B2-HO)
MASTER Laboratory Aid (INT-B2-LA)
MASTER Laboratory Worksheet (INT-B2-LW)
Preventative maintenance records
Calibration records
Repair records
Replacement records
Troubleshooting records

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-B1 "Proper Storage of Circuit Boards"

Introduction:

An instrumentation technician needs to document all activities such as calibration, preventative maintenance, troubleshooting, repairing and replacing. Calibration must be performed against a standard that can be traced back to the National Bureau of Standards (NIST).

Presentation Outline:

I. Using a P&ID (Process Control) Diagram and a Technical Manual for a Pressure Transducer (Or Some Other Process Measuring Device), Generate the Following:
   A. PM record
   B. Calibration record
   C. Troubleshooting record
   D. Repair record
   E. Replacement record

Practical Application:

1. Instructor will demonstrate collecting and recording data.

2. Student will demonstrate collecting and recording data.

Evaluation and/or Verification:

Successful completion of this Technical Module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-B3) dealing with testing and calibrating transducers according to specs.

INT-B2-HO
Collect and Record Data According to Company Requirements
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Demonstrate collecting data according company requirements; and,
b. Demonstrate recording data according to company requirements.

Module Outline:

I. Using a P&ID (Process Control) Diagram and a Technical Manual for a Pressure Transducer (Or Some Other Process Measuring Device), Generate the Following:
   A. PM record
   B. Calibration record
   C. Troubleshooting record
   D. Repair record
   E. Replacement record

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B2-LW
Collect and Record Data According to Company Requirements
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how a technical manual and a P&ID diagram for a control device can be used to generate the following:
   a. PM record;
   b. Calibration record;
   c. Troubleshooting record;
   d. Repair record; and,
   e. Replacement record.

2. Student will demonstrate how a technical manual and a P&ID diagram for a control device can be used to generate the following:
   a. PM record;
   b. Calibration record;
   c. Troubleshooting record;
   d. Repair record; and,
   e. Replacement record.

3. Instructor will grade this activity.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-B3

Subject: **Instrumentation** **Time: 6 Hrs.**

Duty: **Maintain Control Systems**
Task: Test and Calibrate Transducers According to Specs

Objective(s):

Upon completion of this module the student will be able to:
a. Test transducers according to specifications; and,
b. Calibrate transducers according to specifications.

Instructional Materials:

MASTER Handout (INT-B3-HO)
MASTER Laboratory Aid (INT-B3-LA)
MASTER Laboratory Worksheet (INT-B3-LW)
Level Transducer
Flow Transducer
Temperature Transducer
Pressure Transducer

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition
Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-B2 "Collect and Record Data According to Company Requirements"

Introduction:

Transducers are very important components of the instrumentation field. Keeping transducers operating correcting is also important to the process. Testing transducers at regular intervals allows one to measure the various characteristics of the transducer. Calibration of the transducers at regular intervals includes calibration against a standard traceable back to the National Bureau of Standards (NIST).

Presentation Outline:

I. Manufacturer's Technical and Servicing Manual
II. Testing and Calibration Records
III. Field Agreement for Transducer Removal from Service for Testing and Calibration
IV. Tools and Process Flow Diagram
V. Transducer Preparation for Testing
VI. Controller Setting
VII. Remove the Integral and Rate Control Actions While Placing the Proportional Band Setting at 100%
VIII. Remove Transducer from Service
IX. Test and Calibrate Transducer
X. Transducer Placed Back into Service
XI. Record Findings

Practical Application:

1. Instructor will test and calibrate transducer against national standard.

2. Student will test and calibrate transducer against national standard.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-B4) dealing with performing preventative maintenance for control devices.

INT-B3-HO
Test and Calibrate Transducers According to Specs
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test transducers according to specifications; and,
b. Calibrate transducers according to specifications.

Reading Assignments:

Manufacturer's technical manual concerning testing and calibration procedure and values to expect.

Module Outline:

I. Manufacturer's Technical and Servicing Manual
II. Testing and Calibration Records
III. Field Agreement for Transducer Removal from Service for Testing and Calibration
IV. Tools and Process Flow Diagram
V. Transducer Preparation for Testing
VI. Controller Setting
VII. Remove the Integral and Rate Control Actions While Placing the Proportional Band Setting at 100%
VIII. Remove Transducer from Service
IX. Test and Calibrate Transducer
X. Transducer Placed Back into Service
XI. Record Findings

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B3-LW
Test and Calibrate Transducers According to Specs
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

Use the following steps to perform testing and calibrate transducer.

a. Manufacturer's technical and servicing manual;
b. Testing and calibration records;
c. Climate for transducer removal from service for testing and calibration;
d. Tools and process flow diagram;
e. Transducer preparation for testing;
f. Controller setting;
g. Remove the integral and rate control actions while placing the proportional band setting at 100%;
h. Remove transducer from service;
i. Test and calibrate transducer;
j. Transducer placed back into service; and,
k. Record findings.

Instructor will demonstrate. Student will perform similar activity. Instructor will grade student on this activity.

INSTRUMENTATION SERIES

MASTER Technical Module No INT-B4

Subject: **Instrumentation** **Time: 3 Hrs.**

Duty: **Maintain Control Systems**
Task: Perform Preventive Maintenance Procedures for Control Devices

Objective(s):

Upon completion of this module the student will be able to:

a. Safely perform preventative maintenance procedures for control device;
b. Perform inspection;
c. Perform cleaning;
d. Perform testing;
e. Perform adjusting; and,
f. Perform replacement.

Instructional Materials:

Technical manual - control device
Paper and Pencil
Chalkboard
MASTER Handout (INT-B4-HO)
MASTER Laboratory Aid (INT-B4-LA)
MASTER Laboratory Worksheet (INT-B4-LW)

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition
Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-B3 "Test and Calibrate Transducers According to Specs"

Introduction:

Preventative maintenance can be defined as the scheduled action of maintaining equipment. Preventative maintenance greatly increases the life of equipment. If, during preventative maintenance activities, there is a trend toward a failure, then schedule a overhaul or replacement during plant shutdown. There has been some discussion concerning how far and what degree of preventative maintenance is advisable and most cost effective. Today, predictive maintenance is also used by some companies to predict breakdown or failure points, so action can be taken to avoid breakdown of equipment.

Presentation Outline:

I. Good Programs Pay off
   - A. Fewer breakdowns
   - B. Fewer emergencies
   - C. More efficient work plans
   - D. Less overtime
   - E. Longer equipment life
   - F. Equitable use of manpower
   - G. Increased production/decreased downtime
   - H. Cuts in maintenance costs

II. Costs Cut Dramatically

III. Inspections
   - A. Causes of equipment breakdown
   - B. Predictive maintenance
   - C. Previous inspections results
   - D. Operator problems
   - E. Corrective action plans

IV. Establishing Maintenance Routes

V. Steps in Planning
   - A. Review
   - B. Decide
   - C. Implement

VI. Review
   - A. Goals and objectives
   - B. Job orders and PM inspection reports
   - C. Potential problems
   - D. Equipment needs
   - E. Available resources
   - F. Operational budget/needs
   - G. Management changes
   - H. Priorities assessment

VII. Decision-Making

A. Assign priorities
B. Project manpower requirements
C. Estimate materials and equipment needs
D. Coordinate PM by objectives
E. Establish an effective communications system
F. Monitor costs to budget
G. Evaluate opportunities
I. Identify Potential Problems

VIII. Implement
A. Assign priorities to maintenance projects
B. Identify major jobs
C. Assign manpower to jobs
D. Budget to actual expenses variances
E. List potential problems
F. Review and evaluate progress of PM

IX. Maintenance Job Orders (MJO)

X. Priorities
A. Emergency work to be completed
B. Two-week maintenance requirements
C. Four-week routine maintenance
D. Eight-week maintenance job requirements
E. Deferred maintenance vs. manpower availability

XI. Scheduling
A. Short-term scheduling
B. Long-range scheduling

Practical Application:

1. Instructor will perform preventive maintenance procedures on control device.

2. Student will perform preventive maintenance procedures on control device.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-B5) dealing with testing and/or replacing printed circuit boards.

INT-B4-HO
Perform Preventive Maintenance Procedures for Control Devices
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Safely perform preventative maintenance procedures for control device;
b. Perform inspection;
c. Perform cleaning;
d. Perform testing;
e. Perform adjusting; and,
f. Perform replacement.

Module Outline:

I. Good Programs Pay off
   A. Fewer breakdowns
   B. Fewer emergencies
   C. More efficient work plans
   D. Less overtime
   E. Longer equipment life
   F. Equitable use of manpower
   G. Increased production/decreased downtime
   H. Cuts in maintenance costs
II. Costs Cut Dramatically
III. Inspections
   A. Causes of equipment breakdown
   B. Predictive maintenance
   C. Previous inspections results
   D. Operator problems

E. Corrective action plans

IV. Establishing Maintenance Routes

V. Steps in Planning
   A. Review
   B. Decide
   C. Implement

VI. Review
   A. Goals and objectives
   B. Job orders and PM inspection reports
   C. Potential problems
   D. Equipment needs
   E. Available resources
   F. Operational budget/needs
   G. Management changes
   H. Priorities assessment

VII. Decision-Making
   A. Assign priorities
   B. Project manpower requirements
   C. Estimate materials and equipment needs
   D. Coordinate PM by objectives
   E. Establish an effective communications system
   F. Monitor costs to budget
   G. Evaluate opportunities
   I. Identify Potential Problems

VIII. Implement
   A. Assign priorities to maintenance projects
   B. Identify major jobs
   C. Assign manpower to jobs
   D. Budget to actual expenses variances
   E. List potential problems
   F. Review and evaluate progress of PM

IX. Maintenance Job Orders (MJO)

X. Priorities
   A. Emergency work to be completed
   B. Two-week maintenance requirements
   C. Four-week routine maintenance
   D. Eight-week maintenance job requirements
   E. Deferred maintenance vs. manpower availability

XI. Scheduling
   A. Short-term scheduling
   B. Long-range scheduling

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B4-LW
Perform Preventive Maintenance Procedures for Control Devices
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will perform preventive maintenance procedures on control device.

2. Student will practice performing preventive maintenance procedures on control device.

3. Instructor will grade student performing prevention maintenance procedures on control devices.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-B5

Subject: **Instrumentation** **Time: 3 Hrs.**

Duty: **Maintain Control Systems**
Task: Test and/or Replace Printed Circuit Boards

Objective(s):

Upon completion of this module the student will be able to:
a. Test printed circuit boards; and,
b. Replace printed circuit boards.

Instructional Materials:

Printed circuit boards
MASTER Handout (INT-B5-HO)
MASTER Laboratory Aid (INT-B5-LA)
MASTER Laboratory Worksheet (INT-B5-LW)

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition
Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-B4 "Perform Preventive Maintenance Procedures for Control Devices"

Introduction:

Printed circuit boards allow solid state electronic devices a place to reside. The platform may be single or multilayered. Usually the electronic devices are soldered to the circuit board. Sometimes the electronic devices are mounted into a socket which is

soldered to the circuit board. Many instrumentation devices are electronic and use circuit boards to house the electronic devices. Testing and/or replacing circuit boards becomes very important in order to maintain system and component integrity and provide and safe and functional operating system.

Presentation Outline:

I. Printed Circuit Board Terminals
II. Test Points on Printed Circuit Boards
III. Desoldering and Soldering Techniques and Tools Used with Printed Circuit Boards
IV. Heat Sinks
V. IC Sockets
VI. Insulated Long Nose Pliers Usage
VII. Diagonal Cutting Pliers Usage
VIII. Single Sided Boards
IX. Double Sided Boards

Practical Application:

1. Instructor will demonstrate testing and/or replacing printed circuit boards.

2. Student will demonstrate testing and/or replacing printed circuit boards.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-B6) dealing with function checking individual element within loop.

INT-B5-HO
Test and/or Replace Printed Circuit Boards
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test printed circuit boards; and,
b. Replace printed circuit boards.

Module Outline:

I. Printed Circuit Board Terminals
II. Test Points on Printed Circuit Boards
III. Desoldering and Soldering Techniques and Tools Used with Printed Circuit Boards
IV. Heat Sinks
V. IC Sockets
VI. Insulated Long Nose Pliers Usage
VII. Diagonal Cutting Pliers Usage
VIII. Single Sided Boards
IX. Double Sided Boards

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B5-LW
Test and/or Replace Printed Circuit Boards
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to test a printed circuit board.
2. Instructor will identify test points.
3. Instructor will identify terminals.
4. Instructor will use desoldering equipment safely to desolder electronic component.
5. Instructor will use soldering equipment safely to solder electronic component.
6. Instructor will use diagonal pliers to cut wires on circuit board.
7. Instructor will use long nose pliers to handle electronic components on circuit board.
8. Student will demonstrate how to test a printed circuit board.
9. Student will identify test points.
10. Student will identify terminals.
11. Student will use desoldering equipment safely to desolder electronic component.
12. Student will use soldering equipment safely to solder electronic component.
13. Student will use diagonal pliers to cut wires on circuit board.
14. Student will use long nose pliers to handle electronic components on circuit board.
15. Instructor will grade each activity performed by the student.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-B6

Subject: **Instrumentation** **Time: 25 Hrs.**

Duty: **Maintain Control Systems**
Task: Function Check Individual Elements Within Loop

Objective(s):

Upon completion of this module the student will be able to function check individual elements within loop, such as:

a. Transducer;
b. Load cell;
c. Level control;
d. Flow control;
e. Temperature control;
f. Pressure control; and,
g. LVDT.

Instructional Materials:

Transducer
Load cell
Level control
Flow control
Temperature control
Pressure control
LVDT
MASTER Handout (INT-B6-HO)
MASTER Laboratory Aid (INT-B6-LA)
MASTER Laboratory Worksheet (INT-B6-LW)

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition
Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

INT-B5 "Test and/or Replace Printed Circuit Boards"

Introduction:

The functional characteristics of the individual elements that make up a loop give each loop a unique purpose. Checking the characteristics of these elements adds uniformity to the operation of the system.

Presentation Outline:

I. Transducer
II. Load Cell
III. Level Control
IV. Flow Control
V. Temperature Control
VI. Pressure Control
VII. LVDT

Practical Application:

1. Instructor will demonstrate how to function check individual elements in a loop.

2. Student will demonstrate how to function check individual elements in a loop.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-B7) dealing with troubleshooting different types of system modules.

INT-B6-HO
Function Check Individual Elements Within Loop
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to function check individual elements within loop, such as:

a. Transducer;
b. Load cell;
c. Level control;
d. Flow control;
e. Temperature control;
f. Pressure control; and,
g. LVDT.

Module Outline:

I. Transducer
II. Load Cell
III. Level Control
IV. Flow Control
V. Temperature Control
VI. Pressure Control
VII. LVDT

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B6-LW
Function Check Individual Elements Within Loop
Attachment 3: **MASTER** Laboratory Worksheet

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1. Student will practice function checking individual elements within loop:
   a. Transducer;
   b. Load cell;
   c. Level control;
   d. Flow control;
   e. Temperature control;
   f. Pressure control; and,
   g. LVDT.

2. Instructor will grade student's performance in these projects.

INSTRUMENTATION SERIES

MASTER Technical Module No INT-B7

Subject: **Instrumentation** **Time: 6 Hrs.**

Duty: **Maintain Control Systems**
Task: Troubleshoot Different Types of System Modules

Objective(s):

Upon completion of this module the student will be able to:

a. Properly use preliminary procedures for troubleshooting;
b. Attack problems in a logical manner;
c. Use vendor manuals;
d. Use troubleshooting tools; and,
e. Troubleshoot different types of system modules.

Instructional Materials:

System module
Vendor manuals
Troubleshooting guides
MASTER Handout (INT-B7-HO)
MASTER Laboratory Aid (INT-B7-LA)
MASTER Laboratory Worksheet (INT-B7-LW)
MASTER Self-Assessment

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition
Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-B6 "Function Check Individual Elements Within Loop"

Introduction:

Troubleshooting is an important skill for an instrumentation technician. This allows one to locate the problem root cause. Usually the fix is less complicated than the steps involved in troubleshooting. Some people troubleshoot easier than others, however, there are basic steps that all should follow.

Presentation Outline:

I. Preliminary Procedures
II. Logical Techniques
III. Vendor Manual Troubleshooting Guides
IV. Troubleshooting Tools
V. Troubleshooting Procedures

Practical Application:

1. Instructor will demonstrate troubleshooting techniques.
2 Student will demonstrate troubleshooting techniques.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-B8) dealing with testing different types of system modules.

INT-B7-HO
Troubleshoot Different Types of System Modules
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Properly use preliminary procedures for troubleshooting;
b. Attack problems in a logical manner;
c. Use vendor manuals;
d. Use troubleshooting tools; and,
e. Troubleshoot different types of system modules.

Module Outline:

I. Preliminary Procedures
II. Logical Techniques
III. Vendor Manual Troubleshooting Guides
IV. Troubleshooting Tools
V. Troubleshooting Procedures

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B7-LW
Troubleshoot Different Types of System Modules
Attachment 3: **MASTER** Laboratory Worksheet

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1. Student will practice using system modules by:
   a. Properly using preliminary procedures for troubleshooting;
   b. Attacking problems in a logical manner;
   c. Using vendor manuals;
   d. Using troubleshooting tools; and,
   e. Troubleshooting different types of system modules.

2. Instructor will grade student's ability to troubleshoot.

Name:_____ Date:_____

INT-B7
Troubleshoot Different Types of System Modules
Self-Assessment

1. Define troubleshooting.

_____
_____
_____

2. List steps to troubleshoot a system.

_____
_____
_____

INT-B7
Troubleshoot Different Types of System Modules
Self-Assessment Answer Key

1. To search for a problem. When the problem is located, perform steps to eliminate problem.

2. Isolate-Sectionalize.

INSTRUMENTATION SERIES

MASTER Technical Module No INT-B8

Subject: Instrumentation **Time:** 4 Hrs.

Duty: Maintain Control Systems
Task: Test Different Types of System Modules

Objective(s):

Upon completion of this module the student will be able to:

a. Test hermetically sealed module;
b. Test single sided PCB module;
c. Test double sided PCB module;
d. Properly handle heat sinks; and,
e. Use common electronic test equipment.

Instructional Materials:

Oscilloscope
VOM (digital) (high input impedance)
Hermetically sealed module
Single sided PCB module
Double sided PCB module
Heat sink
MASTER Handout (INT-B8-HO)
MASTER Laboratory Aid (INT-B8-LA)
MASTER Laboratory Worksheet (INT-B8-LW)
MASTER Self-Assessment

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition
Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

INT-B6 "Function Check Individual Elements Within Loop"

Introduction:

Electronic devices are usually mounted on printed circuit Boards to conserving space. This is in keeping with miniaturization theme today. Smaller is considered better this presents some special characteristics that must be dealt with also.

Presentation Outline:

I. Single Sided PCB Module
II. Double Sided PCB Module
III. Operate Electronic Test Equipment To Test Module
IV. Test Single Sided PCB Modules
V. Test Double Sided PCB Modules
VI. Test Hermetically Sealed Module

Practical Application:

Student will perform common system module tests. Accurately to 70% in a timely manner.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-B9) dealing with configuring software.

INT-B8-HO
Test Different Types of Systems Modules
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Test hermetically sealed module;
b. Test single sided PCB module;
c. Test double sided PCB module;
d. Properly handle heat sinks; and,
e. Use common electronic test equipment.

Module Outline:

I. Single Sided PCB Module
II. Double Sided PCB Module
III. Operate Electronic Test Equipment To Test Module
IV. Test Single Sided PCB Modules
V. Test Double Sided PCB Modules
VI. Test Hermetically Sealed Module

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Instructor will grade student's ability to :

a. Test hermetically sealed module;
b. Test single sided PCB module;
c. Test double sided PCB module;
d. Properly handle heat sinks; and,
e. Use common electronic test equipment.

Name:_____ Date:_____

INT-B8
Test Different Types of Systems Modules
Self-Assessment

1. PCB stands for _____.

2. Hermetical sealed means _____
_____
_____.

3. List precaution used in handling IC's.
_____
_____
_____

4. IC's are _____.

5. TP's are _____.

6. Double sided PCB modules differ from single sided PCB module by
_____
_____
_____

7. An oscilloscope is used to _____
_____.

8. AN IC logic indicator is used to _____
_____.

INT-B8
Test Different Types of Systems Modules
Self-Assessment Answer Key

1. Printed circuit boards.

2. Sealed so as moisture will not penetrate.

3. Use IC handling tools so hands do not touch. Handle carefully. Handle as if hot.

4. Integrated circuits.

5. Thermal probes.

6. Connection on both sides sometimes.

7. Analyze wave forms or shape.

8. Indicate the presence or absence of a signal.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-B9

Subject: Instrumentation **TIME: 24 Hrs.**

Duty: Maintain Control Systems
Task: Configure Software

Objective(s):

Upon completion of this module the student will be able to:

a. List major parts of computer;
b. Demonstrate a working knowledge of keyboard;
c. Demonstrate a working knowledge of DOS;
d. Demonstrate a working knowledge of Windows 3.1;
e. Demonstrate a working knowledge of Windows 95;
f. Demonstrate a basic knowledge of a word processing software;
g. Demonstrate a basic knowledge of a spreadsheet software;
h. Demonstrate a basic knowledge of a graphic software; and,
i. Demonstrate a basic knowledge of a programming language.

Instructional Materials:

Computer (DOS, Windows, and Windows 95)
MASTER Handout (INT-B9-HO)
MASTER Laboratory Worksheet (INT-B9-LW)
MASTER Self-Assessment

References:

Learning To Use Microsoft Windows 3.1, Shelley, Cashman, and Forsythe, Boyd and Frasier Publishing, Latest Edition
Learning To Use DOS, Shelly, Cashman, and Forsythe, Boyd and Frasier Publishing Company, Latest Edition
Learning To Use Microsoft Word, Shelly, Cashman, and Forsythe, Boyd and Frasier Publishing Company, Latest Edition
Learning To Use Windows 95, etc., Shelly, Cashman, and Forsythe; Boyd and Frasier Publishing, Latest Edition
Learning To Use Microsoft Excel, etc., Shelly, Cashman, and Forsythe; Boyd and Frasier Publishing, Latest Edition
Learning To Use Microsoft PowerPoint, etc., Shelly, Cashman, and Forsythe; Boyd and Frasier Publishing, Latest Edition

Learning To Use Microsoft Access, etc., Shelly, Cashman, and Forsythe; Boyd and Frasier Publishing, Latest Edition

Learning To Use Basic, etc., Shelly, Cashman, and Forsythe; Boyd and Frasier Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

INT-B8 "Test Different Types of Systems Modules"

Introduction:

Software drives many complex systems. This equipment runs plant. In many cases, this may be operational seven (7) days a week, 24 hours a day. Familiarity with today's software is important.

Presentation Outline:

I. Major Parts of Digital and Analog Computer
II. Keyboard Skills
III. DOS
IV. Windows 3.1
V. Windows 95
VI. Word Processing Sofware
VII. Spreadsheet Software
VIII. Graphic Software
IX. Computer Languages - Overview

Practical Application:

Student will demonstrate proficiency in using common software used in complex systems today.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-B10) dealing with repairing different types of system modules.

INT-B9-HO
Configure Software
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the computer lab by not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. List major parts of computer;
b. Demonstrate a working knowledge of keyboard;
c. Demonstrate a working knowledge of DOS;
d. Demonstrate a working knowledge of Windows 3.1;
e. Demonstrate a working knowledge of Windows 95.;
f. Demonstrate a basic knowledge of a word processing software;
g. Demonstrate a basic knowledge of a spreadsheet software;
h. Demonstrate a basic knowledge of a graphic software; and,
i. Demonstrate a basic knowledge of a programming language.

Module Outline:

I. Major Parts of Digital and Analog Computer
II. Keyboard Skills
III. DOS
IV. Windows 3.1
V. Windows 95
VI. Word Processing Software
VII. Spreadsheet Software
VIII. Graphic Software
IX. Computer Languages - Overview

INT-B9-LW
Configure Software
Attachment 2: **MASTER** Laboratory Worksheet

The student shall:

1. Practice booting up a computer;
2. Practice properly powering down computer;
3. Practice using DOS commands;
4. Practice using Windows 3.1;
5. Practice using Windows 95;
6. Practice using a word processing software;
7. Practice using a spreadsheet software;
8. Practice using a graphic software; and,
9. Practice using a programming language.

Name:_____ Date:_____

INT-B9
Configure Software
Self-Assessment

1. Which Windows program is a drawing program?
   a. Paint brush
   b. Card file
   c. Write
   d. Terminal

2. Which Windows program is a word processor?
   a. Paint brush
   b. Card file
   c. Write
   d. Terminal

3. What is Windows ability to run more than one program at a time called?
   a. OLE
   b. GUI
   c. Integration
   d. Multi tasking

4. Which program in the Control Panel lets you select wallpaper?
   a. Desktop
   b. Color
   c. Fonts
   d. Mouse

5. Which program under Windows 3.1 allows you to easily work with files?
   a. Program Manager
   b. File Manager
   c. Write
   d. Control Panel

6. Which phase means to make a group "window" or "icon" "active?
   a. Select a group window
   b. Open a dialog box
   c. Run a group
   d. Select an application window

7. Using Windows 95, the first step to open a program is:
   a. Move mouse to start icon
   b. Move mouse up to programs
   c. Move mouse up to documents
   d. Move mouse to settings

8. Using Windows 95, the second step to open a program is:
   a. Move mouse to start icon
   b. Move mouse up to programs
   c. Move mouse up to documents
   d. Move mouse to settings

9. Using Windows 95, if one wanted to add a pointer, the first step would be to:
   a. Move mouse to start icon
   b. Move mouse up to programs
   c. Move mouse up to documents
   d. Move mouse to settings

10. Using DOS, the command to create a directory is:
   a. MD <enter>
   b. CD <enter>
   c. CD\ <enter>
   d. RD\ <enter>

11. Using DOS, the command to remove a directory is:
   a. MD <enter>
   b. CD <enter>
   c. CD\ <enter>
   d. RD\ <enter>

12. List major hardware parts of a personal computer.

_____

_____

_____

_____

_____

_____

13. The function key on a keyboard are located:
   a. Top horizontal
   b. Bottom horizontal
   c. Left section
   d. Right section

14. The numeric key pad is located:
    a. Top horizontal
    b. Bottom horizontal
    c. Left section
    d. Right section

15. This is a major hardware part of a personal computer:
    a. Paint brush
    b. Write
    c. Monitor
    d. Program Manager

16. The following is a computer language:
    a. BASIC
    b. Program Manager
    c. File Manager
    d. RAM

INT-B9
Configure Software
Self-Assessment Answer Key

1. a
2. c
3. d
4. a
5. b
6. a
7. a
8. b
9. d
10. a
11. d
12. Keyboard
    Mouse
    Monitor
    Central Processing Unit
13. a
14. d
15. c
16. a

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-B10

Subject: **Instrumentation** **Time: 4 Hrs.**

Duty: **Maintain Control Systems**
Task: Repair Different Types of System Modules

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate how to properly use common electronic hand tools;
b. Demonstrate how to remove and replace integrated circuits;
c. Demonstrate how to remove and replace discrete electronic components;
d. Demonstrate how to use power hand tools; and,
e. Demonstrate how to repair system module.

Instructional Materials:

Electronic modules-repair purpose
Electronic modules-replacement purpose
Electrical hand tools
Electronic power tools
Integrated circuits
Discrete electronic components
MASTER Handout (INT-B10-HO)
MASTER Laboratory Aid (INT-B10-LA)
MASTER Laboratory Worksheet (INT-B10-LW)

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition
Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

INT-B9 "Configure Software"

Introduction:

Repairing modules is very important to maintaining system operation. The cost savings is usually less to repair than to replace. An individual that can repair is a valuable asset to a company.

Presentation Outline:

I. Electronic Hand Tools
II. Electronic Components
    A. Discrete Components
    B. Integrated Circuits
III. Electronic Power Hand Tools
IV. Module Description

Practical Application:

1. Instructor will demonstrate practical applications.
2. Student will practice steps and procedures demonstrated by instructor.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-B11) dealing with installing control system hardware.

INT-B10-HO
Repair Different Types of System Modules
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate how to properly use common electronic hand tools;
b. Demonstrate how to remove and replace integrated circuits;
c. Demonstrate how to remove and replace discrete electronic components;
d. Demonstrate how to use power hand tools; and,
e. Demonstrate how to repair system module.

Module Outline:

I. Electronic Hand Tools
II. Electronic Components
    A. Discrete Components
    B. Integrated Circuits
III. Electronic Power Hand Tools
IV. Module Description

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B10-LW
Repair Different Types of System Modules
Attachment 3: **MASTER** Laboratory Worksheet

1, Instructor will:
   a. Demonstrate how to properly use common electronic hand tools;
   b. Demonstrate how to remove and replace integrated circuits;
   c. Demonstrate how to remove and replace discrete electronic components;
   d. Demonstrate how to use power hand tools; and,
   e. Demonstrate how to repair system module.

2. Student will:
   a. Demonstrate how to properly use common electronic hand tools;
   b. Demonstrate how to remove and replace integrated circuits;
   c. Demonstrate how to remove and replace discrete electronic components;
   d. Demonstrate how to use power hand tools; and,
   e. Demonstrate how to repair system module.

3. Instructor will grade practical projects.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-B11

Subject: **Instrumentation** **Time: 6 Hrs.**

Duty: **Maintain Control Systems**
Task: Install Control System Hardware

Objective(s):

Upon completion of this module the student will be able to:

a. Install control system hardware;
b. Proper use of common electrical hand tools;
c. Proper use of common electronic hand tools;
d. Proper use of wrist straps;
e. Proper use of common electrical test equipment;
f. Demonstrate correct handling of printed circuit boards; and,
g. Demonstrate proper handling of static sensitive electronic components.

Instructional Materials:

Electrical hand tools
Electronic hand tools
Wrist strap
Control system hardware
MASTER Handout (INT-B11-HO)
MASTER Laboratory Aid (INT-B11-LA)
MASTER Laboratory Worksheet (INT-B11-LW)

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-B10 "Repair Different Types of System Modules"

Introduction:

Control system hardware is necessary in order to automate the process. Without automation the process would be slow, cumbersome, and inaccurate. This would result in non-uniformity and loss of sales.

Presentation Outline:

I. Install Control System Hardware
II. Proper Use of Common Electrical Hand Tools
III. Proper Use of Common Electronic Hand Tools
IV. Proper Use of Wrist Straps
V. Proper Use of Common Electrical Test Equipment
VI. Demonstrate Current Handling of Printed Circuit Boards
VII. Demonstrate Proper Handling of Static Sensitive Electronic Components

Practical Application:

Students will use electrical and electronic test equipment to check control system hardware.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-B12) dealing with simulating control system check.

INT-B11-HO
Install Control System Hardware
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Install control system hardware;
b. Proper use of common electrical hand tools;
c. Proper use of common electronic hand tools;
d. Proper use of wrist straps;
e. Proper use of common electrical test equipment;
f. Demonstrate correct handling of printed circuit boards; and,
g. Demonstrate proper handling of static sensitive electronic components.

Module Outline:

I. Install Control System Hardware
II. Proper Use of Common Electrical Hand Tools
III. Proper Use of Common Electronic Hand Tools
IV. Proper Use of Wrist Straps
V. Proper Use of Common Electrical Test Equipment
VI. Demonstrate Current Handling of Printed Circuit Boards
VII. Demonstrate Proper Handling of Static Sensitive Electronic Components

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Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment;
Not participating in horse play or practical joking; and,
If in doubt as to safe operation of the equipment, **STOP** and seek guidance from the instructor.

INT-B11-LW
Install Control System Hardware
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor should demonstrate how to:
   a. Install control system hardware;
   b. Properly use common electrical hand tools;
   c. Properly use common electronic hand tools;
   d. Properly use wrist straps;
   e. Properly use common electrical test equipment;
   f. Demonstrate current handling of printed circuit boards; and,
   g. Demonstrate proper handling of static sensitive electronic components.

2. Student shall demonstrate how to:
   a. Install control system hardware;
   b. Properly use common electrical hand tools;
   c. Properly use common electronic hand tools;
   d. Properly use wrist straps;
   e. Properly use common electrical test equipment;
   f. Demonstrate current handling of printed circuit boards; and,
   g. Demonstrate proper handling of static sensitive electronic components.

3. Instructor will grade student's lab work.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-B12

Subject: **Instrumentation** **Time: 24 Hrs.**

Duty: **Maintain Control Systems**
Task: Simulate Control System Check

Objective(s):

Upon completion of this module the student will be able to:

a. Simulate control system check;
b. Build control system; and,
c. Use calibration sheet to identify control system components.

Instructional Materials:

Control system devices
MASTER Handout (INT-B12-HO)
MASTER Laboratory Aid (INT-B12-LA)
MASTER Laboratory Worksheet (INT-B12-LW)

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-B11 "Install Control System Hardware"

Introduction:

Control systems allow smaller voltages and currents to control larger voltages and currents.

Presentation Outline:

I. Control System Definition
II. Control System Components
III. Simulation Definition
IV. Control System Check

Practical Application:

1. Instructor will simulate control system check.
2. Student will simulate control system check.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-B13) dealing with loop check control system.

INT-B12-HO
Simulate Control System Check
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Simulate control system check;
b. Build control system; and,
c. Use calibration sheet to identify control system components.

Module Outline:

I. Control System Definition
II. Control System Components
III. Simulation Definition
IV. Control System Check

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B12-LW
Simulate Control System Check
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Student will practice:
   a. Simulating control system check;
   b. Building control system; and,
   c. Using calibration sheet to identify control system components.

2. Instructor will grade student's ability to perform simulation of control system.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-B13

Subject: **Instrumentation** **Time: 6 Hrs.**

Duty: **Maintain Control Systems**
Task: Loop Check Control System

Objective(s):

Upon completion of this module the student will be able to:

a. Identify loops;
b. Describe basic loop components; and,
c. Describe how loop functions.

Instructional Materials:

Instrumentation loop
MASTER Handout (INT-B13-HO)
MASTER Laboratory Worksheet (INT-B13-LW)
MASTER Laboratory Aid (INT-B13-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-B12 "Simulate Control System Check"

Introduction:

Instrumentation devices are electrically tied together in a loop. P&ID diagram are drawn in a loop. Therefore, the loop is a basic configuration in instrumentation circuits.

Presentation Outline:

I. Loop Definition
II. Loop Components
III. Loop Check Control System Procedures

Practical Application:

1. Instructor will loop check control system.
2. Student will loop check control system.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-B14) dealing with performing on-line testing.

INT-B13-HO
Look Check Control System
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Identify loops;
b. Describe basic loop components; and,
c. Describe how loop functions.

Module Outline:

I. Loop Definition
II. Loop Components
III. Loop Check Control System Procedures

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B13-LW
Look Check Control System
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Student will loop check control system.

2. Instructor will grade student's ability to loop check a control system.

Name:_____ Date:_____

INT-B13
Look Check Control System
Self-Assessment

1. Identify loops.

_____
_____
_____

2. Describe basic loop components.

_____
_____
_____

3. Describe how loop functions.

_____
_____
_____

INT-B13
Look Check Control System
Self-Assessment Answer Key

1. A sequence of instruction that is expected until terminal conditions prevail.

2. A forward path, feedback path, summing point, field devices, controller.

3. Instructions are given by field devices at summary point. This signal combines with the incoming signal at summing point. Controller compensates for differences. Controller then sends differential signal to the field devices.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-B14

Subject: **Instrumentation** **TIME: 6 Hrs.**

Duty: **Maintain Control Systems**
Task: Perform On-Line Testing

Objective(s):

Upon completion of this module the student will be able to:

a. Perform on-line testing;
b. Demonstrate familiarity with simple loops;
c. Demonstrate familiarity with multiple loops;
d. Demonstrate familiarity with DCS system;
e. Demonstrate safety precautions associated with on-line testing; and,
f. Demonstrate using PLC on-line testing features.

Instructional Materials:

DCS system
Programmable controller
Single loop control system
Multiple loop control system
MASTER Handout (INT-B14-HO)
MASTER Laboratory Aid (INT-B14-LA)
MASTER Laboratory Worksheet (INT-B14-LW)
MASTER Self-Assessment

References:

Vendor Manuals: Programmable Controllers; Programming, Hardware, Software Setup, Latest Editions
DCS System: Eg.: Provox by Fisher Roscmount; Hardware; Software, Latest Editions

Note: Your choice of PLC and DCS system will determine how you tailor practical and written question.

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-B13 "Loop Check Control Systems"

Introduction:

Testing on-line is very important in order to maintain production levels.

Presentation Outline:

I. Single Loop
II. Multi-Loop
III. PLC-On-Line Features
IV. DCS Systems-On-Line

Practical Application:

Student will demonstrate proficiency in using a PLC and DCS system to perform on-line testing.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C1) dealing with testing and calibrating pressure, level, flow, and temperature switches.

INT-B14-HO
Perform On-Line Testing
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Perform on-line testing;
b. Demonstrate familiarity with simple loops;
c. Demonstrate familiarity with multiple loops;
d. Demonstrate familiarity with DCS system;
e. Demonstrate safety precautions associated with on-line testing; and,
f. Demonstrate using PLC on-line testing features.

Module Outline:

I. Single Loop
II. Multi-Loop
III. PLC-On-Line Features
IV. DCS Systems-On-Line

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B14-LW
Perform On-Line Testing
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Student will:
   a. Perform on-line testing;
   b. Demonstrate familiarity with simple loops;
   c. Demonstrate familiarity with multiple loops;
   d. Demonstrate familiarity with DCS system;
   e. Demonstrate safety precautions associated with on-line testing; and,
   f. Demonstrate using PLC on-line testing features.

2. Instructor will grade the student's ability to:
   a. Perform on-line testing;
   b. Demonstrate familiarity with simple loops;
   c. Demonstrate familiarity with multiple loops;
   d. Demonstrate familiarity with DCS system;
   e. Demonstrate safety precautions associated with on-line testing; and,
   f. Demonstrate using PLC on-line testing features.

Name:_____ Date:_____

INT-B14
Perform On-Line Testing
Self-Assessment

1. Place the PLC on-line by:

_____
_____
_____

2. Place the DCS system on-line by:

_____
_____
_____

3. Compare a single loop system to a multiple loop system.

_____
_____
_____

4. List common safety precautions associated with on-line testing.

_____
_____
_____

INT-B14
Perform On-Line Testing
Self-Assessment Answer Key

1. Switch on CPU module or software activation.

2. Software activation.

3. Multiple loops are two or more loops in series or parallel operation.

4. May cause equipment to move when not wanted. Could be very unsafe.

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and repair transmitters	C-12 Test different field sensing elements, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Calibrate transmitters	C-15 Tune controllers: pneumatic and electronic	C-16 Trouble-shoot and repair plant computing systems relating to process controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and repair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and configure smart field devices, i.e., transmitters and valves	C-35 Operate control systems including single element, cascade, ratio, and feedforeward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Determine proper tools, equipment, and materials to perform the job	D-3 Coordinate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment isolation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibration procedures	D-8 Follow specifications and procedures	D-9 Perform algebraic operations	D-10 Perform basic trigonometric functions	D-11 Perform banic calculus operations		
E Collect and File Data	E-1 Record test/calibration data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise procedures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Application of ISA/IC standards	F-5 Understand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Understand personal computers	F-10 Attend on-going safety training courses	F-11 Participate in plant related training	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C1

Subject: **Instrumentation** **Time: 24 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Test And Calibrate Pressure, Level, Flow, and Temperature Switches

Objective(s):

Upon completion of this module the student will be able to:

a. Test pressure switches;
b. Test level switches;
c. Test flow switches;
d. Test temperature switches;
e. Calibrate pressure switches;
f. Calibrate level switches;
g. Calibrate flow switches; and,
h. Calibrate temperature switches.

Instructional Materials:

Pressure switches
Level switches
Flow switches
Temperature switches
Vendor manuals - pressure switch
Vendor manuals - level switch
Vendor manuals - flow switch
Vendor manuals - temperature switch
MASTER Handout (INT-C1-HO)
MASTER Laboratory Worksheet (INT-C1-LW)
MASTER Laboratory Aid (INT-C1-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition

Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-B14 "Perform On-Line Testing"

Introduction:

The four major process variables are pressure, level, flow, and temperature. The proper operation of the switches that control these variables are very important to an instrumentation technician and to the process itself.

Presentation Outline:

I. Testing Pressure Switches
II. Testing Level Switches
III. Testing Flow Switches
IV. Testing Temperature Switches
V. Calibrating Pressure Switches
VI. Calibrating Level Switches
VII. Calibrating Flow Switches
VIII. Calibrating Temperature Switches

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C2) dealing with troubleshooting and repairing pressure, level, flow, and temperature switches.

INT-C1-HO

Test and Calibrate Pressure, Level, Flow, and Temperature Switches

Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Test pressure switches;
b. Test level switches;
c. Test flow switches;
d. Test temperature switches;
e. Calibrate pressure switches;
f. Calibrate level switches;
g. Calibrate flow switches; and,
h. Calibrate temperature switches.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, published by McGraw-Hill, Latest Edition:

Chapter	Title
9	Pressure Measurements
12	Flow Measurements
13	Liquid Level Measurements
14	Temperature Measurements

Module Outline:

I. Testing Pressure Switches
II. Testing Level Switches
III. Testing Flow Switches

IV. Testing Temperature Switches
V. Calibrating Pressure Switches
VI. Calibrating Level Switches
VII. Calibrating Flow Switches
VIII. Calibrating Temperature Switches

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C1-LW
Test and Calibrate Pressure, Level, Flow, and Temperature Switches
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Test pressure switches;
   b. Test level switches;
   c. Test flow switches;
   d. Test temperature switches;
   e. Calibrate pressure switches;
   f. Calibrate level switches;
   g. Calibrate flow switches; and,
   h. Calibrate temperature switches.

2. Student will demonstrate how to:
   a. Test pressure switches;
   b. Test level switches;
   c. Test flow switches;
   d. Test temperature switches;
   e. Calibrate pressure switches;
   f. Calibrate level switches;
   g. Calibrate flow switches; and,
   h. Calibrate temperature switches.

3. Instructor will grade student's ability to:
   a. Test pressure switches;
   b. Test level switches;
   c. Test flow switches;
   d. Test temperature switches;
   e. Calibrate pressure switches;
   f. Calibrate level switches;
   g. Calibrate flow switches; and,
   h. Calibrate temperature switches.

Name:_____ Date:_____

INT-C1
Test and Calibrate Pressure, Level, Flow, and Temperature Switches
Self-Assessment

1. List steps to test a pressure switch.

2. List steps to test a level switch.

3. List steps to test a flow switch.

4. List steps to test a temperature switch.

5. List steps to calibrate a pressure switch.

6. List steps to calibrate a level switch.

7. List steps to calibrate a flow switch.

8. List steps to calibrate a temperature switch.

INT-C1

Test and Calibrate Pressure, Level, Flow, and Temperature Switches

Self-Assessment Answer Key

1. Manually apply pressure so switch is activated. This should happen at a predetermined pressure. Ohm switch for operation.

2. Manually trip switch arm. Switch should activate. Ohm switch for operation.

3. Cause predetermined amounts of flow to make switch to activate. Ohm switch for operation.

4. Change temperature so switch is activated. Ohm switch for operation.

5. Check operation against desired amount. Adjust knob for desired operation.

6. Check operation against desired amount. Adjust lever for desired operation.

7. Check operation against desired amount. Adjust paddle for desired operation.

8. Check operation against desired amount. Adjust anticipators for desired operation.

INT-C2

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C2

Subject: **Instrumentation** **Time: 30 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Troubleshoot and Repair Pressure, Level, Flow, and Temperature Switches

Objective(s):

Upon completion of this module the student will be able to:

a. Troubleshoot pressure switches;
b. Troubleshoot level switches;
c. Troubleshoot flow switches;
d. Troubleshoot temperature switches;
e. Repair pressure switches;
f. Repair level switches;
g. Repair flow switches; and,
h. Repair temperature switches.

Instructional Materials:

Pressure switches
Level switches
Flow switches
Temperature switches
Vendor manuals - pressure switch
Vendor manuals - level switch
Vendor manuals - flow switch
Vendor manuals - temperature switch
MASTER Handout (INT-C2-HO)
MASTER Laboratory Worksheet (INT-C2-LW)
MASTER Laboratory Aid (INT-C2-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition

Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C1 "Test and Calibrate Pressure, Level, Flow, and Temperature Switches"

Introduction:

The four major process variables are pressure, level, flow, and temperature. The proper operation of the switches that control these variables are very important to an instrumentation technician and to the process itself.

Presentation Outline:

I. Troubleshooting Pressure Switches
II. Troubleshooting Level Switches
III. Troubleshooting Flow Switches
IV. Troubleshooting Temperature Switches
V. Repairing Pressure Switches
VI. Repairing Level Switches
VII. Repairing Flow Switches
VIII. Repairing Temperature Switches

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C3) dealing with adjusting dampers and positioners.

INT-C2-HO
Troubleshoot and Repair Pressure, Level, Flow, and Temperature Switches
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Troubleshoot pressure switches;
b. Troubleshoot level switches;
c. Troubleshoot flow switches;
d. Troubleshoot temperature switches;
e. Repair pressure switches;
f. Repair level switches;
g. Repair flow switches; and,
h. Repair temperature switches.

Reading Assignments

Industrial Instrumentation Fundamentals, Fribance, published by McGraw-Hill, Latest Edition:

Chapter	Title
9	Pressure Measurements
12	Flow Measurements
13	Liquid Level Measurements
14	Temperature Measurements

Module Outline:

I. Troubleshooting Pressure Switches
II. Troubleshooting Level Switches

III. Troubleshooting Flow Switches
IV. Troubleshooting Temperature Switches
V. Repairing Pressure Switches
VI. Repairing Level Switches
VII. Repairing Flow Switches
VIII. Repairing Temperature Switches

INT-C2-LA
Troubleshoot and Repair Pressure, Level, Flow, and Temperature Switches
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C2-LW
Troubleshoot and Repair Pressure, Level, Flow, and Temperature Switches
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Troubleshoot pressure switches;
   b. Troubleshoot level switches;
   c. Troubleshoot flow switches;
   d. Troubleshoot temperature switches;
   e. Repair pressure switches;
   f. Repair level switches;
   g. Repair flow switches; and,
   h. Repair temperature switches.

2. Student will demonstrate how to:
   a. Troubleshoot pressure switches;
   b. Troubleshoot level switches;
   c. Troubleshoot flow switches;
   d. Troubleshoot temperature switches;
   e. Repair pressure switches;
   f. Repair level switches;
   g. Repair flow switches; and,
   h. Repair temperature switches.

3. Instructor will grade student's ability to:
   a. Troubleshoot pressure switches;
   b. Troubleshoot level switches;
   c. Troubleshoot flow switches;
   d. Troubleshoot temperature switches;
   e. Repair pressure switches;
   f. Repair level switches;
   g. Repair flow switches; and,
   h. Repair temperature switches.

Name:_____ Date:_____

INT-C2
Troubleshoot and Repair Pressure, Level, Flow, and Temperature Switches
Self-Assessment

1. List steps to troubleshoot a pressure switch.

2. List steps to troubleshoot a level switch.

3. List steps to troubleshoot a flow switch.

4. List steps to troubleshoot a temperature switch.

5. List steps to repair a pressure switch.

6. List steps to repair a level switch.

7. List steps to repair a flow switch.

8. List steps to repair a temperature switch.

INT-C2

Troubleshoot and Repair Pressure, Level, Flow, and Temperature Switches

Self-Assessment Answer Key

1. Check switch movement. Check cut in pressure. Check cut out pressure. Check differential pressure.

2. Check contacts. Check level unit.

3. Check contacts. Check air flow switch. Check sail switch. Check contacts.

4. Check contacts. Check expansion unit.

5. Replace spring. Replace contacts. Clean contacts. Lubricate spring.

6. Clean contacts. Replace level unit.

7. Replace air flow or sail switch. Lubricate air flow or sail switch. Replace air flow or sail switch. Clean contacts.

8. Clean contacts. Replace contacts. Replace expansion unit.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C3

Subject: **Instrumentation** **Time: 6 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Adjust Dampers and Positioners

Objective(s):

Upon completion of this module the student will be able to:
a. Adjust damper; and,
b. Adjust positioners.

Instructional Materials:

Damper
Positioner
MASTER Handout (INT-C3-HO)
MASTER Laboratory Worksheet (INT-C3-LW)
MASTER Laboratory Aid (INT-C3-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C2 "Troubleshoot and Repair Pressure, Level, Flow, and Temperature Switches"

Introduction:

Accurate control of flow is obtainable with dampers and positioners. Adjusting these devices in order to obtain desired flow is part of an instrumentation technicians duties.

Presentation Outline:

I. Damper
II. Damper Major Components
III. Positioner
IV. Positioner Major Components
V. Adjusting the Damper
VI. Adjusting the Positioner

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C4) dealing with troubleshooting and adjusting control drive (damper).

INT-C3-HO
Adjust Dampers and Positioners
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Adjust damper; and,
b. Adjust positioners.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, published by McGraw-Hill, Latest Edition:

Chapter	Title
10	Transducer-Positioner

Module Outline:

I. Damper
II. Damper Major Components
III. Positioner
IV. Positioner Major Components
V. Adjusting the Damper
VI. Adjusting the Positioner

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C3-LW
Adjust Dampers and Positioners
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Adjust damper; and,
   b. Adjust positioner.

2. Student will demonstrate how to:
   a. Adjust damper; and,
   b. Adjust positioner.

3. Instructor will grade student's ability to:
   a. Adjust damper; and,
   b. Adjust positioner.

Name:_____ Date:_____

INT-C3
Adjust Dampers and Positioners
Self-Assessment

1. Define purpose of damper.

2. Define purpose of positioner.

3. List major types of damper.

4. List steps to adjust damper.

5. List steps to adjust positioner.

INT-C3
Adjust Dampers and Positioners
Self-Assessment Answer Key

1. Provides a variable resistance for regulating the volumetric flow of gas or air.

2. The controlled motion operates in accordance with instruction which specify next required position. This position may be converted into a signal.

3. Butterfly, curtain, flat, louvre, slide

4. Check physical movement of damper.

5. Read output. If positioner is proportional, adjust position to portion of output.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C4

Subject: Instrumentation **Time: 9 Hrs.**

Duty: Maintain Field Instrumentation Devices
Task: Troubleshoot Control Drive (Damper)

Objective(s):

Upon completion of this module the student will be able to troubleshoot damper.

Instructional Materials:

MASTER Handout (INT-C4-HO)
MASTER Laboratory Worksheet (INT-C4-LW)
MASTER Laboratory Aid (INT-C4-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C3 "Adjust Dampers and Positioners"

Introduction:

Dampers allows one to offer variable air volume control. This offers more precise control for uniform production.

Presentation Outline:

I. Define Damper

II. Define Modulation
III. Operation of Damper
IV. Damper Types
V. Damper Components
VI. PM for Damper Components
VII. Troubleshooting Damper Components

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C5) dealing with testing and calibrating indicators and gauges.

INT-C4-HO
Troubleshoot Control Drive (Damper)
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to troubleshoot damper.

Reading Assignments:

Refrigeration and Air Conditioning Systems, Althouse, Goodheart-Willcox, Latest Edition:

Chapter	Title
19	Dampers

Module Outline:

I. Define Damper
II. Define Modulation
III. Operation of Damper
IV. Damper Types
V. Damper Components
VI. PM for Damper Components
VII. Troubleshooting Damper Components

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C4-LW
Troubleshoot Control Drive (Damper)
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Identify major parts of a damper;
   b. Classify dampers (butterfly, multiple blade and split damper);
   c. Compare manual to automatic operation;
   d. Explain purpose of fire damper;
   e. Perform PM on dampers; and,
   f. Troubleshoot damper.

2. Student will demonstrate how to:
   a. Identify major parts of a damper;
   b. Classify dampers (butterfly, multiple blade and split damper);
   c. Compare manual to automatic operation;
   d. Explain purpose of fire damper;
   e. Perform PM on dampers; and,
   f. Troubleshoot damper.

3. Instructor will grade student's ability to:
   a. Identify major parts of a damper;
   b. Classify dampers (butterfly, multiple blade and split damper);
   c. Compare manual to automatic operation;
   d. Explain purpose of fire damper;
   e. Perform PM on dampers; and,
   f. Troubleshoot damper.

Name:_____ Date:_____

INT-C4
Troubleshoot Control Drive (Damper)
Self-Assessment

1. Describe how a butterfly damper works.

2. Describe how curtain type damper works.

3. Describe how a flat damper works.

4. Describe how a louvre type works.

5. Describe how a slide type damper works.

6. Describe damper lose.

7. Describe how to troubleshoot a damper?

INT-C4
Troubleshoot Control Drive (Damper)
Self-Assessment Answer Key

1. A single blade pivoted about its center.

2. Flexible material moving in a vertical plane as it is rolled.

3. One or more blades each pivoted about one edge.

4. Several blades each pivoted about its center and working simultaneously.

5. Single blade which moves substantially normal to flow.

6. Reduction of static pressure of air flowing across a damper.

7. Compare output to desired output. Physically adjust damper to desired value. Check for physical impairment that might restrict movement.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C5

Subject: **Instrumentation** **Time: 9 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Test and Calibrate Indicators and Gauges

Objective(s):

Upon completion of this module the student will be able to:

a. Test indicators;
b. Test gauges;
c. Calibrate indicators; and,
d. Calibrate gauges.

Instructional Materials:

MASTER Handout (INT-C5-HO)
MASTER Laboratory Worksheet (INT-C5-LW)
MASTER Laboratory Aid (INT-C5-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C4 "Troubleshoot and Adjust Control Drive (Damper)"

Introduction:

Proper operation and indication is essential to a process operation testing and calibration on a frequent and timely manner is important to maintain consistent and uniform processes.

Presentation Outline:

I. Major Parts of Indicators
II. Testing Procedure for Indicator
III. Calibration Procedures for Indicator
IV. Major Parts of Gauges
V. Testing Procedure for Gauges
VI. Calibration Procedure for Gauges

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C6) dealing with troubleshooting and repairing indicators.

INT-C5-HO
Test and Calibrate Indicators and Gauges
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Test indicators;
b. Test gauges;
c. Calibrate indicators; and,
d. Calibrate gauges.

Reading Assignments:

Industrial Instrumentation Fundamentals, Frabrane, McGraw-Hill Publisher, Latest Edition:

Chapter	Title
17	Indicating and Registering Equipment

Module Outline:

I. Major Parts of Indicators
II. Testing Procedure for Indicator
III. Calibration Procedures for Indicator
IV. Major Parts of Gauges
V. Testing Procedure for Gauges
VI. Calibration Procedure for Gauges

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C5-LW
Test and Calibrate Indicators and Gauges
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Test indicators;
   b. Test gauges;
   c. Calibrate indicators; and,
   d. Calibrate gauges.

2. Student will demonstrate how to:
   a. Test indicators;
   b. Test gauges;
   c. Calibrate indicators; and,
   d. Calibrate gauges.

3. Instructor will grade student's ability to:
   a. Test indicators;
   b. Test gauges;
   c. Calibrate indicators; and,
   d. Calibrate gauges.

Name:_____ Date:_____

INT-C5
Test and Calibrate Indicators and Gauges
Self-Assessment

1. List steps to calibrate a pressure gauge.

_____
_____
_____

2. List steps to calibrate an indicator.

_____
_____
_____

3. List common testing procedure for a pressure gauge.

_____
_____
_____

4. List common testing procedures for a panel indicator.

_____
_____
_____

INT-C5
Test and Calibrate Indicators and Gauges
Self-Assessment Answer Key

1. Use standard. Check pressure gauge against standard. Adjust as necessary.

2. Use standard check indicator against standard. Adjust as necessary.

3. Test for indication. Test for amount of indication.

4. Test for indication. Test for proper amount of indication.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C6

Subject: **Instrumentation** **Time: 15 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Troubleshoot and Repair Indicators

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshooter indicators; and,
b. Repair indicators.

Instructional Materials:

Assortment of indicators
Data logger
MASTER Handout (INT-C6-HO)
MASTER Laboratory Worksheet (INT-C6-LW)
MASTER Laboratory Aid (INT-C6-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C5 "Test and Calibrate Indicators and Gauges"

Introduction:

Indicators give a visual indication of the status of operation characteristic.

Presentation Outline:

I. Define Indicators
II. List Major Types of Indicators
III. Troubleshoot Indicator
IV. Repair Indicator

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C7) dealing with testing and calibrating transmitters.

INT-C6-HO
Troubleshoot and Repair Indicators
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshooter indicators; and,
b. Repair indicators.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishing, Latest Edition

Chapter	Title
19	Industrial Measurements

Module Outline:

I. Define Indicators
II. List Major Types of Indicators
III. Troubleshoot Indicator
IV. Repair Indicator

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C6-LW
Troubleshoot and Repair Indicators
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. List major types of indicators;
   b. Compare analog indicators to digital indicators;
   c. Describe how pressure indicator works;
   d. Describe how current indicator works;
   e. Describe how voltage indicator works; and,
   f. Use data logger.

2. Student will demonstrate how to:
   a. List major types of indicators;
   b. Compare analog indicators to digital indicators;
   c. Describe how pressure indicator works;
   d. Describe how current indicator works;
   e. Describe how voltage indicator works; and,
   f. Use data logger.

3. Instructor will grade student's ability to:
   a. List major types of indicators;
   b. Compare analog indicators to digital indicators;
   c. Describe how pressure indicator works;
   d. Describe how current indicator works;
   e. Describe how voltage indicator works; and,
   f. Use data logger.

Name:_____ Date:_____

INT-C6
Troubleshoot and Repair Indicators
Self-Assessment

1. Compare analog to digital.

_____
_____
_____

2. Explain how sensors and indicators work.

_____
_____
_____

3. What is a data logger?

_____
_____
_____

4. What is D/A?

_____
_____
_____

5. Explain how pressure indicator works.

_____
_____
_____

INT-C6
Troubleshoot and Repair Indicators
Self-Assessment Answer Key

1. Digital uses numbers to express values. Analog uses a pointer to point to a value on a scale.

2. Sensors are inputs to a controller. Indicators are outputs from a controller.

3. Keeps a log of data as data changes.

4. Digital to analog.

5. Many use a bourdon tube to sense a pressure difference.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C7

Subject: **Instrumentation** **Time: 35 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Test and Calibrate Transmitters

Objective(s):

Upon completion of this module the student will be able to:

a. Test pressure transmitter;
b. Test level transmitter;
c. Test flow transmitter;
d. Test temperature transmitter; and,
e. Test smart transmitter.

Instructional Materials:

MASTER Handout (INT-C7-HO)
MASTER Laboratory Worksheet (INT-C7-LW)
MASTER Laboratory Aid (INT-C7-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C6 "Troubleshoot and Repair Indicators"

Introduction:

Transmitters charge variables from one form to another form. Transmitters are used a great deal in process and assembly industries.

Presentation Outline:

I. Level Transmitters
II. Flow Transmitters
III. Pressure Transmitter
IV. Temperature Transmitter
V. Test Procedure for Transmitter

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C8) dealing with testing and calibrating recorders.

INT-C7-HO
Test and Calibrate Transmitters
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Test pressure transmitter;
b. Test level transmitter;
c. Test flow transmitter;
d. Test temperature transmitter; and,
e. Test smart transmitter.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishing, Latest Edition:

Chapter	Title
19	Industrial Measurements

Module Outline:

I. Level Transmitters
II. Flow Transmitters
III. Pressure Transmitter
IV. Temperature Transmitter
V. Test Procedure for Transmitter

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C7-LW
Test and Calibrate Transmitters
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will:
   a. Demonstrate how to use:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   b. Demonstrate how to test:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.

2. Student will:
   a. Demonstrate how to use:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   b. Demonstrate how to test:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.

3. Instructor will grade student's ability to:
   a. Use:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   b. Test:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;

(4) Flow transmitter; and,
(5) Smart transmitter.

Name:_____ Date:_____

INT-C7
Test and Calibrate Transmitters
Self-Assessment

1. The most accurate standards are those with the _____ tolerances.
   a. Highest
   b. Largest
   c. Smallest
   d. Broadest

2. _____ standards use physical properties of matter and physical laws to provide a standard for comparison.
   a. Physical
   b. Primary
   c. National
   d. Secondary

3. _____ are sets consisting of precision parts that are not interchangeable with components in other sets.
   a. Cylinders
   b. Cylinders and weight systems
   c. Weight systems
   d. None of the above

4. Flushing the connection before connecting the test instrument to be calibrated to a hydraulic deadweight tester's instrument connection port ensures that there are no _____.
   a. Leaks
   b. Air bubbles
   c. Oil
   d. Oxygen

5. The operating fluid in hydraulic testers is a _____.
   a. Liquid
   b. Mercury
   c. Gas
   d. Oil

6. In a hydraulic deadweight tester, the pressure balance point is achieved by forces acting on a _____ assembly.
   a. Piston and cylinder
   b. Ratchet and gear
   c. Ball and nozzle
   d. None of the above

7. The least accurate standards are those with the _____ tolerances.
   a. Widest
   b. Narrowest
   c. Smallest
   d. All of the above

INT-C7
Test and Calibrate Transmitters
Self-Assessment Answer Key

1. C
2. A
3. D
4. B
5. D
6. A
7. A

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C8

Subject: **Instrumentation** **Time: 12 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Test And Calibrate Recorders

Objective(s):

Upon completion of this module the student will be able to:
a. Test recorders; and,
b. Calibrate recorders.

Instructional Materials:

MASTER Handout (INT-C8-HO)
MASTER Laboratory Worksheet (INT-C8-LW)
MASTER Laboratory Aid (INT-C8-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C7 Test Transmitters"

Introduction:

Recorders allow a human to see both real time and historical data. Decisions can be made to change settings to produce a uniform product.

Presentation Outline:

I. Strip Chart Recorder
II. Circular Chart Recorder
III. Event Recorder
IV. Digital Recorder
V. Testing Recorder
VI. Calibrating Recorder

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C9) dealing with troubleshooting and repairing recorders.

INT-C8-HO
Test and Calibrate Recorders
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test recorders; and,
b. Calibrate recorders.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishers, Latest Edition:

Chapter	Title
17	Indicators and Recording Equipment

Module Outline:

I. Strip Chart Recorder
II. Circular Chart Recorder
III. Event Recorder
IV. Digital Recorder
V. Testing Recorder
VI. Calibrating Recorder

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C8-LW
Test and Calibrate Recorders
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Test recorders; and,
   b. Calibrate recorders.

2. Student will demonstrate how to;
   a. Test recorders; and,
   b. Calibrate recorders.

3. Instructor will grade student's ability to:
   a. Test recorders; and,
   b. Calibrate recorders.

Name:_____ Date:_____

INT-C8
Test and Calibrate Recorders
Self-Assessment

1. Describe how strip chart recorder works.

2. Describe how event recorder works.

3. Describe how circular recorder works.

4. List calibration procedure for circular chart recorder.

5. List testing procedure for circular recorder.

INT-C8
Test and Calibrate Recorders
Self-Assessment Answer Key

1. Chart in regular form with long sides. Pen is placed on chart and chart rolled lengthwise. Pen indicates value of measured characteristic.

2. Make impression on chart when unsual occupance happens.

3. Round chart. Pen rides in position as chart rotates.

4. Test against lab standard.

5. Test pen fluid flow. Test pen pressure. Test movement or pen test rotation. Test rotation speed.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C9

Subject: Instrumentation **Time: 12 Hrs.**

Duty: Maintain Field Instrumentation Devices.
Task: Troubleshoot and Repair Recorders

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot recorders; and,
b. Repair recorders.

Instructional Materials:

Assortment of recorders (circular chart recorder, strip chart recorder)
Assortment of printers
MASTER Handout (INT-C9-HO)
MASTER Laboratory Worksheet (INT-C9-LW)
MASTER Laboratory Aid (INT-C9-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C8 "Test and Calibrate Recorders"

Introduction:

Recorders provide a permanent record over a period of time. This information is needed to more adequately analyze events occurring to what degree and at what time.

Presentation Outline:

I. Define Recorders
II. Strip Chart
III. Circular Chart
IV. Parts of Recorders
V. Printer
VI. Types of Printers
VII. Event Recorder

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C10) dealing with troubleshooting linear variable differential transformers.

INT-C9-HO
Troubleshoot and Repair Recorders
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot recorders; and,
b. Repair recorders.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishing, Latest Edition:

Chapter	Title
19	Industrial Measurements

Module Outline:

I. Define Recorders
II. Strip Chart
III. Circular Chart
IV. Parts of Recorders
V. Printer
VI. Types of Printers
VII. Event Recorder

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C9-LA
Troubleshoot and Repair Recorders
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Troubleshoot strip chart recorder;
   b. Troubleshoot circular chart recorder;
   c. Repair strip chart recorder; and,
   d. Repair circular chart recorder.

2. Student will demonstrate how to:
   a. Troubleshoot strip chart recorder;
   b. Troubleshoot circular chart recorder;
   c. Repair strip chart recorder; and,
   d. Repair circular chart recorder.

3. Instructor will grade student's ability to:
   a. Troubleshoot strip chart recorder;
   b. Troubleshoot circular chart recorder;
   c. Repair strip chart recorder; and,
   d. Repair circular chart recorder.

Name:_____ Date:_____

INT-C9
Troubleshoot and Repair Recorders
Self-Assessment

1. Compare strip chart to circular chart recorder.

_____
_____
_____

2. List major parts of strip chart recorders.

_____
_____
_____

3. List major parts of circular chart provider.

_____
_____
_____

4. List steps to troubleshoot circular chart recorder.

_____
_____
_____

5. List steps to troubleshoot strip chart recorder.

_____
_____
_____

INT-C9
Troubleshoot and Repair Recorders
Self-Assessment Answer Key

1. Circular chart is round. Strip chart is rectangular. (Continuous roll of paper)

2. Cover. Indicating hardware. Chart paper.

3. Indicating hardware. Cover. Circular chart.

4. Check for proper motion of chart (should be slow and continuous). Check for proper ink level. Check for clear tubes for ink flow. Check for proper movement of indicator.

5. Check for proper motion of chart (should be slow and continous). Check for proper ink level. Check for clear tubes for ink flow. Check for proper movement of indicator.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C10

Subject: Instrumentation **Time:** 8 Hrs.

Duty: Maintain Field Instrumentation Devices
Task: Troubleshoot Linear Variable Differential Transformers

Objective(s):

Upon completion of this module the student will be able to troubleshoot LVDT.

Instructional Materials:

LVDT
Multimeter
MASTER Handout (INT-C10-HO)
MASTER Laboratory Worksheet (INT-C10-LW)
MASTER Laboratory Aid (INT-C10-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C9 "Troubleshoot and Repair Recorders"

Introduction:

LVDT's are used for comparison projects. LVDT's can be used to weigh and compare to range of acceptable values.

Presentation Outline:

I. Define LVDT
II. Parts of LVDT
III. Function of LVDT parts
IV. Troubleshoot LVDT

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C11) dealing with troubleshooting, repairing, and calibrating transmitters.

INT-C10-HO
Troubleshoot Linear Variable Differential Transformers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to troubleshoot LVDT.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishing, Latest Edition:

Chapter	Title
10	Pressure Measurements

Module Outline:

I. Define LVDT
II. Parts of LVDT
III. Function of LVDT parts
IV. Troubleshoot LVDT

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C10-LW
Troubleshoot Linear Variable Differential Transformers
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Explain LVDT operation;
   b. Properly use LVDT;
   c. Troubleshoot LVDT; and,
   d. Test LVDT for proper operation.

2. Student will:
   a. Explain LVDT operation;
   b. Properly use LVDT;
   c. Troubleshoot LVDT; and,
   d. Test LVDT for proper operation.

3. Instructor will grade student's ability to:
   a. Explain LVDT operation;
   b. Properly use LVDT;
   c. Troubleshoot LVDT; and,
   d. Test LVDT for proper operation.

Name:_____ Date:_____

INT-C10
Troubleshoot Linear Variable Differential Transformers
Self-Assessment

1. Define LVDT.

2. Explain operation of LVDT.

3. List steps to troubleshoot an LVDT.

4. List steps to test an LVDT.

INT-C10
Troubleshoot Linear Variable Differential Transformers
Self-Assessment Answer Key

1. Linear variable differential transformers.

2. A transformer with one primary windings, two secondary windings, and movable core. Over a wide range, the output voltage is the analog of the core positions.

3. Check output voltage to each secondary winding. Check input voltage to primary winding. Check total output voltage.

4. When core in neutral position, the two secondary voltages are equal.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C11

Subject: **Instrumentation** **Time: 40 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Troubleshoot and Repair Transmitters

Objective(s):

Upon completion of this module the student will be able to:

a. Troubleshoot pressure transmitter;
b. Troubleshoot level transmitter;
c. Troubleshoot flow transmitter;
d. Troubleshoot temperature transmitter;
e. Troubleshoot smart transmitter;
f. Repair pressure transmitter;
g. Repair level transmitter;
h. Repair flow temperature;
i. Repair temperature transmitter; and,
j. Repair smart transmitter.

Instructional Materials:

MASTER Handout (INT-C11-HO)
MASTER Laboratory Aid (INT-C11-LA)
MASTER Laboratory Worksheet (INT-C11-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C10 "Troubleshoot Linear Variable Differential Transformers"

Introduction:

Transmitters change variables from one form to another form. Transmitter are used a great deal in process industries.

Presentation Outline:

I. Level Transmitters
II. Flow Transmitters
III. Pressure Transmitter
IV. Temperature Transmitter
V. Troubleshoot Procedure for Transmitter
VI. Repair Procedure for Transmitter

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C12) dealing with testing different field sensing elements, flow, temperature, pressure, and level.

INT-C11-HO
Troubleshoot and Repair Transmitters
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Troubleshoot pressure transmitter;
b. Troubleshoot level transmitter;
c. Troubleshoot flow transmitter;
d. Troubleshoot temperature transmitter;
e. Troubleshoot smart transmitter;
f. Repair pressure transmitter;
g. Repair level transmitter;
h. Repair flow temperature;
i. Repair temperature transmitter; and,
j. Repair smart transmitter.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishing, Latest Edition:

Chapter	Title
19	Industrial Measurements

Module Outline:

I. Level Transmitters
II. Flow Transmitters
III. Pressure Transmitter
IV. Temperature Transmitter

V. Troubleshoot Procedure for Transmitter
VI. Repair Procedure for Transmitter

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C11-LW
Troubleshoot and Repair Transmitters
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Use:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   b. Troubleshoot:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   c. Repair:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.

2. Student will demonstrate how to:
   a. Use:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   b. Troubleshoot:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   c. Repair:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.

3. Instructor will grade student's ability to:
   a. Use:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   b. Troubleshoot:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   c. Repair:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.

Name:_____ Date:_____

INT-C11
Troubleshoot and Repair Transmitters
Self-Assessment

1. The first step in troubleshooting is to _____.
   a. Gather information
   b. Run to defective component
   c. Alert operator on console

2. A failure that causes other components to fail is called _____.
   a. Feedforward
   b. Feedback
   c. Cascading

3. The best source of schematics, parts lists, and instructions for repair and is usually _____.
   a. Co-workers
   b. Theory manuals
   c. Manufacturers' literature
   d. On-the-job training

4. Individual instrument histories include _____.
   a. A list of instrument failures
   b. A list of maintenance schedules
   c. A record of all maintenance for a certain instrument
   d. The shift work schedule

5. An instrument group failure history might include data on _____.
   a. All pressure instruments from one vender
   b. All pressure transmitters from one vender
   c. All transmitters in a portion of the process

6. Which of the following are seldom used for routine maintenance?
   _____
   a. Electrical or electronic tools
   b. Mechanical tools
   c. Large power tools
   d. Test stands

7. Which of the following instruments is always suitable for field use?

_____

a. Battery-powered multimeter
b. Calibration furnace
c. Deadweight tester

8. When you are asked to repair a faulty instrument, you should first _____.

a. Gather details about the failure
b. Inspect the instrument
c. Select a new instrument

9. The final step in a troubleshooting job should be _____.

a. Calibrating the device
b. Recording details of the job
c. Repairing the device

10. The best reason for considering scrapping and replacing a device is if _____.

a. A newer design is available
b. It is fairly inexpensive
c. It requires excessive maintenance

INT-C11
Troubleshoot and Repair Transmitters
Self-Assessment Answer Key

1. a
2. c
3. c
4. c
5. b
6. c
7. a
8. a
9. b
10. c

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C12

Subject: Instrumentation **Time: 18 Hrs.**

Duty: Maintain Field Instrumentation Devices
Task: Test Different Field Sensing Elements, Flow, Temperature, Pressure, and Level

Objective(s):

Upon completion of this module the student will be able to:

a. Test flow element;
b. Test level element;
c. Test pressure element; and,
d. Test temperature element.

Instructional Materials:

MASTER Handout (INT-C12-HO)
MASTER Laboratory Aid (INT-C12-LA)
MASTER Laboratory Worksheet (INT-C12-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C11 "Troubleshoot and Repair Transmitters"

Introduction:

Flow, level, pressure and temperature and temperature elements are used in industry to communicate with smart devices for decision parameters.

Presentation Outline:

I. Flow Element
II. Level Element
III. Pressure Element
IV. Temperature Element

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C13) dealing with installing/replacing field sensing elements.

INT-C12-HO
Test Different Field Sensing Elements, Flow, Temperature, Pressure, and Level
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Test flow element;
b. Test level element;
c. Test pressure element; and,
d. Test temperature element.

Reading Assignments:

Instrumentation, by Kirk, ATS Publishers, Latest Edition:

Chapter	Title
8	Control Element

Module Outline:

I. Flow Element
II. Level Element
III. Pressure Element
IV. Temperature Element

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C12-LW
Test Different Field Sensing Elements, Flow, Temperature, Pressure, and Level
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Test flow element
   b. Test level element
   c. Test pressure element
   d. Test temperature element

2. Student will demonstrate how to:
   a. Test flow element
   b. Test level element
   c. Test pressure element
   d. Test temperature element

3. Instructor will grade student's ability to:
   a. Test flow element
   b. Test level element
   c. Test pressure element
   d. Test temperature element

Name:_____ Date:_____

INT-C12
Test Different Field Sensing Elements, Flow, Temperature, Pressure, and Level
Self-Assessment

1. Describe flow element.

2. Describe level element.

3. Describe pressure element.

4. Describe temperature element.

5. Describe flow element testing procedures.

6. Describe level element testing procedures.

7. Describe pressure element testing procedures.

8. Describe temperature element testing procedures.

INT-C12
Test Different Field Sensing Elements, Flow, Temperature, Pressure, and Level
Self-Assessment Answer Key

1. Device used to measure flow (process variable) - usually GPM.

2. Device used to measure level (pressure variable) - usually feet or inches.

3. Device used to measure pressure (process variable) - usually PSI.

4. Device used to measure temperature (process variable) - usually degree Celsius.

5. Check for flow. Check for amount of flow. Check operation of sensor.

6. Check for level indication.

7. Check strain gage operation.

8. Check temperature seal. Check against known temperature.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C13

Subject: **Instrumentation** **Time: 30 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Install/Replace Field Sensing Elements

Objective(s):

Upon completion of this module the student will be able to:
a. Install field sensing elements; and,
b. Replace field elements.

Instructional Materials:

MASTER Handout (INT-C13-HO)
MASTER Laboratory Aid (INT-C13-LA)
MASTER Laboratory Worksheet (INT-C13-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C12 "Test Different Field Sensing Elements, Flow, Temperature, Pressure, and Level"

Introduction:

Field sensing elements are the devices used in the plant to relay information to the computers in a control room. The computers in the control room make decisions based on inputs from field devices.

Presentation Outline:

I. Definition
II. Manipulated Variable
III. Electric Actuators
IV. Pneumatic Actuators
V. Control Valves
VI. Hydraulic Actuators

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C14) dealing with calibrating transmitters.

INT-C13-HO
Install/Replace Field Sensing Elements
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Install field sensing elements; and,
b. Replace field elements.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishing, Latest Edition:

Chapter	Title
19	Industrial Measurements

Module Outline:

I. Definition
II. Manipulated Variable
III. Electric Actuators
IV. Pneumatic Actuators
V. Control Valves
VI. Hydraulic Actuators

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C13-LW
Install/Replace Field Sensing Elements
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Install field sensing elements; and,
   b. Replace field elements.

2. Student will demonstrate how to:
   a. Install field sensing elements; and,
   b. Replace field elements.

3. Instructor will grade student's ability to:
   a. Install field sensing elements; and,
   b. Replace field elements.

Name:_____ Date:_____

INT-C13
Install/Replace Field Sensing Elements
Self-Assessment

1. Which of the following originates a feedback signal?
   a. Directly controlled variable
   b. Disturbance
   c. Indirectly controlled variable
   d. Manipulated variable

2. Which of the following is an example of a final control element?
   a. Bellows
   b. Clock
   c. Thermometer
   d. Valve

3. The important difference between open-and closed-loop systems is that the closed-loop system _____.
   a. Controls through digital signals
   b. Provides automatic control through feedback
   c. Requires manual operation
   d. Uses smaller actuators

4. The most important consideration in loop control locations is _____.
   a. Accessibility
   b. Accuracy
   c. Cost
   d. Response

5. A disturbance inside a control loop _____.
   a. Does not affect output
   b. Is a manipulated variable
   c. Is corrected for by feedback
   d. Results in a process error

6. Which of the following may condition a signal in a final control subsystem?
   a. Electric motor
   b. Hydraulic piston
   c. Solenoid
   d. Transistor amplifier

7. The device in a final control subsystem that receives a conditioned signal and converts it to some form of mechanical energy is a(n) _____.
   a. Actuator
   b. Amplifier
   c. P/I converter
   d. Transducer

8. Which of the following statements is true?
   a. Current signals are easier to amplify than voltage signal.
   b. Current signals are easier to measure than voltage signals.
   c. Voltage signals are affected by transmission line resistance.
   d. Voltage signals are harder to generate that current signals.

9. The pressure range of most pneumatic control signals is usually _____.
   a. 0 to 50 mV
   b. 1 to 5V
   c. 3 to 15 psi
   d. 4 to 20 mA

INT-C13
Install/Replace Field Sensing Elements
Self-Assessment Answer Key

1. b
2. d
3. b
4. a
5. c
6. d
7. d
8. c
9. c

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C14

Subject: **Instrumentation** **Time: 30 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Calibrate Transmitters

Objective(s):

Upon completion of this module the student will be able to:
a. Name common types of transmitters; and,
b. Calibrate transmitters.

Instructional Materials:

Transmitter
Hand tools
Multimeter
Calibrate test equipment
MASTER Handout (INT-C14-HO)
MASTER Laboratory Aid (INT-C14-LA)
MASTER Laboratory Worksheet (INT-C14-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C13 "Install/Replace Field Sensing Elements"

Introduction:

Transmitters change process variables to other variables.

Presentation Outline:

I. Define Transmitter
II. Types of Transmitters
III. Standards
IV. Manometers
V. Hydraulic Deadweight Testers
VI. Pneumatic Deadweight Testers
VII. Ice Bath Tester
VIII. Pressure Tester
IX. Glossary (Workbook)

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C15) dealing with tuning controllers: pneumatic and electronic.

INT-C14-HO
Calibrate Transmitters
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Name common types of transmitters; and,
b. Calibrate transmitters.

Reading Assignments:

Primary Calibration Standards, ISA, Latest Edition:

Chapter	**Title**
Workbook	Standards
	Manometers
	Deadweight Testers

Module Outline:

I. Define Transmitter
II. Types of Transmitters
III. Standards
IV. Manometers
V. Hydraulic Deadweight Testers
VI. Pneumatic Deadweight Testers
VII. Ice Bath Tester
VIII. Pressure Tester
IX. Glossary (Workbook)

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C14-LW
Calibrate Transmitters
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Use calibration test equipment; and,
   b. Calibrate transmitters.

2. Student will demonstrate how to:
   a. Use calibration test equipment; and,
   b. Calibrate transmitters.

3. Instructor will grade student's ability to:
   a. Use calibration test equipment; and,
   b. Calibrate transmitters.

Name:_____ Date:_____

INT-C14
Calibrate Transmitters
Self-Assessment

1. A typical calibration period for a piece of electronic test equipment is ____.
   a. One year
   b. One week
   c. One month
   d. Two weeks

2. In which test station could you expect to find a dynamometer?
   a. Electrical
   b. Hydraulic
   c. Pneumatic
   d. Electronic

3. The instrument air source at a pneumatic workbench should provide air in the range of _____.
   a. 4 to 20 psi
   b. 3 to 15 psi
   c. 0 to 10 psi
   d. 25 to 100 psi

4. After cleaning, the next in serving a pneumatic instrument is to _____.
   a. Test it
   b. Calibrate it
   c. Repair it
   d. Test and evaluate it

5. Electronic test stands usually include _____.
   a. Hydraulic oil
   b. A means of examining output signals
   c. A prony brake
   d. A means of examining input signals

6. The instrument used to identify sources of noise is the _____.
   a. Voltmeter
   b. Ammeter
   c. Wattmeter
   d. Oscilloscope

INT-C14
Calibrate Transmitters
Self-Assessment Answer Key

1. a
2. a
3. d
4. d
5. b
6. d

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C15

Subject: **Instrumentation** **Time: 30 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Tune Controllers: Pneumatic and Electronic

Objective(s):

Upon completion of this module the student will be able to:
a. Tune pneumatic controller; and,
b. Tune electronic controller.

Instructional Materials:

Pneumatic controller
Electronic controller
MASTER Handout (INT-C15-HO)
MASTER Laboratory Aid (INT-C15-LA)
MASTER Laboratory Worksheet (INT-C15-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C14 "Calibrate Transmitters"

Introduction:

Controllers play a vital role in industry. Controllers sense input condition, make decision, and output signals depending on the way the controller is programmed. Most controllers are smart devices.

Presentation Outline:

I. Purpose of Controllers
II. Kinds of Controllers
III. Controller Modes
IV. Controller Terminology
V. P
VI. I
VII. D
VII. PID
IX. Tuning
X. Pneumatic vs. Electronics

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C16) dealing with troubleshooting and repairing plant computing systems relating to process controls.

INT-C15-HO
Tune Controllers: Pneumatic and Electronic
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Tune pneumatic controller; and,
b. Tune electronic controller.

Reading Assignments:

Instrumentation, by Kirk, ATS Publications, Latest Edition:

Chapter	Title
8	Control

Module Outline:

I. Purpose of Controllers
II. Kinds of Controllers
III. Controller Modes
IV. Controller Terminology
V. P
VI. I
VII. D
VII. PID
IX. Tuning
X. Pneumatic vs. Electronics

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C15-LW
Tune Controllers: Pneumatic and Electronic
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Tune pneumatic controller; and,
   b. Tune electronic controller

2. Student's will demonstrate how to:
   a. Tune pneumatic controller; and,
   b. Tune electronic controller

3. Instructor will grade student's ability to:
   a. Tune pneumatic controller; and,
   b. Tune electronic controller

Name:_____ Date:_____

INT-C15
Tune Controllers: Pneumatic and Electronic
Self-Assessment

1. In signal evaluation, the controller must determine the size and direction of the _____.
   a. control point
   b. error
   c. final control element
   d. set point

2. An analog output signal between 0 and 10 mV represents a pressure measurement between 20 and 100 psi. What value does an output of 7.5 mV represent?
   a. 20 psi
   b. 60 psi
   c. 80 psi
   d. 100 psi

3. If a temperature sensor has a range of 80 to 240° F and the temperature controller indicates 50%, the measured value is _____.
   a. 80° F
   b. 120° F
   c. 160° F
   d. 240° F

4. What is the proportional band of a system in which a change in flow from 15% to 85% of full range causes a valve to move from full open to full closed?
   a. 15%
   b. 30%
   c. 70%
   d. 85%

5. The purpose of adding integral to proportional control is to _____.
   a. eliminate offset
   b. eliminate the need for feedback
   c. reduce system time lag
   d. regulate two variables from one controller

6. An instrument that measures weight _____.
   a. balances one mass against another
   b. gives the same reading at any elevation
   c. must include a part that deforms in some way
   d. wears out at the pivot

7. If pressure remains constant, thermal energy must be increased in order to change _____.
   a. steam to ice
   b. steam to water
   c. water to ice
   d. water to steam

8. The error signal from a controller is proportional to the difference between the feedback signal and the _____.
   a. amount of system disturbance
   b. final control element position signal
   c. set point
   d. value of the manipulated variable

9. Which of the following values expresses 75% of span for a direct-acting temperature controller with a range of -20 to +140° F?
   a. 60° F
   b. 80° F
   c. 100° F
   d. 120° F

10. A controller with a gain of 4 has a proportional band of _____.
    a. 4%
    b. 10%
    c. 25%
    d. 40%

11. Resets per minute describes the ramp action of a controller with _____ control.
    a. derivative
    b. integral
    c. proportional
    d. rate

12. In a cascade control system, the final control element is controlled by _____.

a. either the primary or secondary controller
b. the master controller
c. the output of a summing device
d. the slave controller

INT-C15
Tune Controllers: Pneumatic and Electronic
Self-Assessment Answer Key

1. a
2. c
3. c
4. c
5. a
6. c
7. d
8. c
9. c
10. a
11. b
12. d

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C16

Subject: **Instrumentation** **Time: 30 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Troubleshoot and Repair Plant Computing Systems Relating to Process Controls

Objective(s):

Upon completion of this module the student will be able to:

a. Troubleshoot plant computing systems relating to process controls; and,
b. Repair plant computing systems relating to process controls.

Instructional Materials:

Computer
Hand tools
Multimeter
Scope-dual trace
Signal generator
Logic probe
MASTER Handout (INT-C16-HO)
MASTER Laboratory Aid (INT-C16-LA)
MASTER Laboratory Worksheet (INT-C16-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C15 "Tune Controllers: Pneumatic and Electronic"

Introduction:

Computers, or smart controllers, are required to operate the very complex process controls. In addition to operating the system the computers must be programmed for safety purposes. This increases the complexity of the computer systems.

Presentation Outline:

I. Define Computer
II. Hardware
III. Software
IV. Process Controls
V. Computers in Process Controls

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C17) dealing with troubleshoot and replacing solenoid valves.

INT-C16-HO
Troubleshoot and Repair Plant Computing Systems Relating to Process Controls
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Troubleshoot plant computing systems relating to process controls; and,
b. Repair plant computing systems relating to process controls.

Reading Assignments:

Instrumentation, by Kirk, ATS Publishers, Latest Edition:

Chapter	Title
14	Electric Controls

Module Outline:

I. Define Computer
II. Hardware
III. Software
IV. Process Controls
V. Computers in Process Controls

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C16-LW
Troubleshoot and Repair Plant Computing Systems Relating to Process Controls
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Troubleshoot plant computing systems relating to process controls; and,
   b. Repair plant computing systems relating to process controls.

2. Student will be graded on their ability to:
   a. Troubleshoot plant computing systems relating to process controls; and,
   b. Repair plant computing systems relating to process controls.

Name:_____ Date:_____

INT-C16
Troubleshoot and Repair Plant Computing Systems Relating to Process Controls
Self-Assessment

1. Define hardware.

2. Define software.

3. Compare Windows to DOS.

4. Define DCS.

5. Compare DCS to PLC.

INT-C16
Troubleshoot and Repair Plant Computing Systems Relating to Process Controls
Self-Assessment Answer Key

1. Physical parts.
2. Magnetic written instructions.
3. Windows is more graphic, less commands.
4. Digital control system.
5. Usually DCS has an hierarchy that places it above the PLC.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C17

Subject: **Instrumentation** **Time: 7 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Troubleshoot and Replace Solenoid Valves

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot solenoid valves; and,
b. Replace solenoid valves.

Instructional Materials:

Solenoid valve assortment
Multimeter
MASTER Handout (INT-C17-HO)
MASTER Laboratory Aid (INT-C17-LA)
MASTER Laboratory Worksheet (INT-C17-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C16 "Troubleshoot and Repair Plant Computing Systems Relating to Process Controls"

Introduction:

Solenoid valves are used to control fluid flow, direction of fluid flow and amount of fluid flow. Air is also. Air can be controlled by solenoid valves.

Presentation Outline:

I. Define Solenoid Valve
II. Parts of Solenoid Valve
III. Troubleshoot Steps
IV. Replacement Steps

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C18) dealing with performing preventive maintenance procedures for field devices.

INT-C17-HO
Troubleshoot and Replace Solenoid Valves
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot solenoid valves; and,
b. Replace solenoid valves.

Reading Assignments:

Refrigeration-Air Conditioning System, Althouse, Goodheart-Wilcox Publishing, Latest Edition:

Chapter	Title
4	Controls

Module Outline:

I. Define Solenoid Valve
II. Parts of Solenoid Valve
III. Troubleshoot Steps
IV. Replacement Steps

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C17-LW

Troubleshoot and Replace Solenoid Valves

Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Use solenoid valve;
   b. List parts of solenoid valve;
   c. Troubleshoot steps for solenoid valve; and,
   d. Replacement steps for solenoid valve.

2. Student will:
   a. Use solenoid valve;
   b. List parts of solenoid valve;
   c. Troubleshoot steps for solenoid valve; and,
   d. Replacement steps for solenoid valve.

3. Instructor will grade student's ability to:
   a. Use solenoid valve;
   b. List parts of solenoid valve;
   c. Troubleshoot steps for solenoid valve; and,
   d. Replacement steps for solenoid valve.

Name:_____ Date:_____

INT-C17
Troubleshoot and Replace Solenoid Valves
Self-Assessment

1. Define solenoid valve.

_____
_____
_____

2. List four types of solenoid valves.

_____
_____
_____

3. List steps to troubleshoot solenoid valves.

_____
_____
_____

4. List steps to replace solenoid valves.

_____
_____
_____

INT-C17
Troubleshoot and Replace Solenoid Valves
Self-Assessment Answer Key

1. A tubular current activated coil that uses magnetic action to perform work. May be used to control fluids. Two major parts-solenoid and plunger.

2. Control, double acting cylinder, four way, two way.

3. Check for proper supply voltage (#10%). Check for proper plunger operation.

4. Turn off power to solenoid valve. Remove screws. Remove cover. Remove solenoid. Replace solenoid. Replace screws. Apply power.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C18

Subject: **Instrumentation** **Time: 15 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Perform Preventive Maintenance Procedures for Field Devices

Objective(s):

Upon completion of this module the student will be able to perform preventive maintenance for field devices.

Instructional Materials:

Insulation tester
DIP tester
Vender maintenance manuals
PM software (example: PMC)
MASTER Handout (INT-C18-HO)
MASTER Laboratory Aid (INT-C18-LA)
MASTER Laboratory Worksheet (INT-C18-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C17 "Troubleshoot and Replace Solenoid Valves"

Introduction:

Preventive maintenance results is lower downtime.

Presentation Outline:

I. Define Preventive Maintenance
II. Define Predictive Maintenance
III. Reliability and Maintenance
IV. Remote Marginal Equipment
V. Recondition Old Equipment
VI. Maintenance of New Equipment
VII. Equipment Familiarity
VIII. Scheduled Inspections
IX. Typical Maintenance Equipment
X. Equipment Start-Up
XI. Performance Data
XII. Determine Critical Equipment
XIII. Records
XIV. Housekeeping

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C19) dealing with testing and repairing thermocouples.

INT-C18-HO

Perform Preventive Maintenance Procedures for Field Devices

Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to perform preventive maintenance for field devices.

Reading Assignments:

Westinghouse Electric Maintenance Hints, Westinghouse Electric Corporation, Latest Edition

Chapter	Title
2	Maintenance of Installed Equipment

Module Outline:

I. Define Preventive Maintenance
II. Define Predictive Maintenance
III. Reliability and Maintenance
IV. Remote Marginal Equipment
V. Recondition Old Equipment
VI. Maintenance of New Equipment
VII. Equipment Familiarity
VIII. Scheduled Inspections
IX. Typical Maintenance Equipment
X. Equipment Start-Up
XI. Performance Data
XII. Determine Critical Equipment

XIII. Records
XIV. Housekeeping

595 A

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C18-LW
Perform Preventive Maintenance Procedures for Field Devices
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate:
   a. Performing P.M. on a piece of equipment (This could be picked from the Westinghouse maintenance hints or an instrumentation vendors manuals.); and,
   b. Software P.M. program usage.

2. Student will demonstrate proficiency of selected P.M. procedures and using P.M. software.

Name:_____ Date:_____

INT-C18
Perform Preventive Maintenance Procedures for Field Devices
Self-Assessment

1. Define preventive maintenance.

_____
_____
_____

2. Define predictive maintenance.

_____
_____
_____

INT-C18
Perform Preventive Maintenance Procedures for Field Devices
Self-Assessment Answer Key

1. Maintenance designed to prevent breakdowns during normal operation.

2. Use past history to predict trends so P.M. can be performed.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C19

Subject: **Instrumentation** **Time: 3 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Test and Replace Thermocouples

Objective(s):

Upon completion of this module the student will be able to:
a. Test thermocouples; and,
b. Replace thermocouples.

Instructional Materials:

Thermocouple assortment
Milvolt voltmeter
RTD
Powerpile
MASTER Handout (INT-C19-HO)
MASTER Laboratory Worksheet (INT-C19-LW)
MASTER Laboratory Aid (INT-C19-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C18 "Perform Preventive Maintenance Procedures for Field Devices"

Introduction:

Thermocouples provide a conversion of heat into a generated voltage. The generated voltage is proportional to amount of heat. Furnaces, boilers, etc. Use thermocouples for flame detection and to regulate the amount of heat.

Presentation Outline:

I. Define Thermocouple
II. How Thermocouple Works
III. Types of Thermocouples
IV. Test Thermocouple
V. Replace Thermocouple
VI. Powerpile
VII. RTD

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C20) dealing with checking and testing vibration sensing elements.

INT-C19-HO
Test and Replace Thermocouples
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test thermocouples; and,
b. Replace thermocouples.

Reading Assignments:

Refrigeration and Air Conditioning, Althouse, Goodheart-Willcox Publishers, Latest Edition:

Chapter	Title
20	Heating Systems

Module Outline:

I. Define Thermocouple
II. How Thermocouple Works
III. Types of Thermocouples
IV. Test Thermocouple
V. Replace Thermocouple
VI. Powerpile
VII. RTD

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C19-LW
Test and Replace Thermocouples
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Identify common types of thermocouples;
   b. Test a thermocouple;
   c. Replace a thermocouple;
   d. Identify a powerpile;
   e. Identify a RTO;
   f. Test a RTD; and,
   g. Test a powerpile.

2. Student will demonstrate how to:
   a. Identify common types of thermocouples;
   b. Test a thermocouple;
   c. Replace a thermocouple;
   d. Identify a powerpile;
   e. Identify a RTO;
   f. Test a RTD; and,
   g. Test a powerpile.

3. Instructor will grade student's ability to:
   a. Identify common types of thermocouples;
   b. Test a thermocouple;
   c. Replace a thermocouple;
   d. Identify a powerpile;
   e. Identify a RTO;
   f. Test a RTD; and,
   g. Test a powerpile.

Name:_____ Date:_____

INT-C19
Test and Replace Thermocouples
Self-Assessment

1. Compare thermocouple to thermopile.

_____
_____
_____

2. Explain what thermocouple does.

_____
_____
_____

3. What is a RTD?

_____
_____
_____

4. List steps to test thermocouple.

_____
_____
_____

5. List steps to replace thermocouple.

_____
_____
_____

INT-C19
Test and Replace Thermocouples
Self-Assessment Answer Key

1. A powerpile is several thermocouples.

2. A temperature sensitive device. Two dissimilar materials are heated and they produce a current.

3. Resistor temperature device.

4. Check output voltage with voltmeter (using known temperature).

5. Turn off control power. Reduce temperature to ambient temperature. Replace thermocouple. Change temperature. Turn on power.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C20

Subject: Instrumentation **Time: 30 Hrs.**

Duty: Maintain Field Instrumentation Devices
Task: Check and Test Vibration Sensing Elements

Objective(s):

Upon completion of this module the student will be able to:

a. Check vibration sensing elements; and,
b. Test vibration sensing elements.

Instructional Materials:

Vibration sensing elements
Vibration software
MASTER Handout (INT-C20-HO)
MASTER Laboratory Worksheet (INT-C20-LW)
MASTER Laboratory Aid (INT-C20-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C19 "Test and Replace Thermocouples"

Introduction:

Vibration causes equipment to wear out permanently. This increase cost.

Presentation Outline:

I. Vibration
II. Frequency
III. Resonance
IV. Displacement
V. Velocity
VI. Acceleration
VII. Natural Frequency
VIII. Amplitude
IX. Spectrum Plot
X. Compression
XI. Extraction

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C21) dealing with inspecting and troubleshooting power supplies and converters.

INT-C20-HO
Check and Test Vibration Sensing Elements
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Check vibration sensing elements; and,
b. Test vibration sensing elements.

Reading Assignments:

Mechanical Vibrations, Hartoq-Dover Publishers, Latest Edition:

Chapter	**Title**
6	Rotating Machinery

Module Outline:

I. Vibration
II. Frequency
III. Resonance
IV. Displacement
V. Velocity
VI. Acceleration
VII. Natural Frequency
VIII. Amplitude
IX. Spectrum Plot
X. Compression
XI. Extraction

INT-C20-LA
Check and Test Vibration Sensing Elements
Attachment 2: **MASTER** Laboratory LA

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C20-LW
Check and Test Vibration Sensing Elements
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Check vibration sensing elements; and,
   b. Test vibration sensing elements.

2. Student will:
   a. Check vibration sensing elements; and,
   b. Test vibration sensing elements.

3. Instructor will grade student's ability to:
   a. Check vibration sensing elements; and,
   b. Test vibration sensing elements.

Name:_____ Date:_____

INT-C20
Check and Test Vibration Sensing Elements
Self-Assessment

1. Define vibration.

2. Define frequency.

3. Define displacement.

4. Define amplitude.

5. Define acceleration.

6. Define natural frequency.

7. Define compression.

8. Define resonance.

INT-C20
Check and Test Vibration Sensing Elements
Self-Assessment Answer Key

1. A periodic movement or oscillation of a device.

2. Rate of signal oscillation in hertz.

3. Amount of movement.

4. Height of oscillation.

5. Rate of movement.

6. The wave frequency at which mechanical or electrical resonance is achieved.

7. Force acting opposite to stretch. Force against device. May cause device to shrink.

8. Natural frequency.

INT-C21

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C21

Subject: **Instrumentation** **Time: 20 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Inspect and Troubleshoot Power Supplies And Converters

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot power supply; and,
b. Repair power supply.

Instructional Materials:

Multimeter
Power supply
MASTER Handout (INT-C21-HO)
MASTER Laboratory Worksheet (INT-C21-LW)
MASTER Laboratory Aid (INT-C21-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C20 "Check and Test Vibration Sensing Elements"

Introduction:

Power supplies charge AC voltage to DC voltage. Many electronic devices use a power supply as the beginning stage.

Presentation Outline:

I. Define Power Supply
II. Single Phase Power Supply
III. Transformer
IV. Regulator
V. Filter
VI. Conversion
VII. Three Phase Power Supply

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C22) dealing with testing and calibrating control valve actuators.

INT-C21-HO
Inspect and Troubleshoot Power Supplies and Converters
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot power supply; and,
b. Repair power supply.

Reading Assignments:

Instrumentation, by Kirk, ATS Publishers, Latest Edition:

Chapter	Title
8	Electricity

Module Outline:

I. Define Power Supply
II. Single Phase Power Supply
III. Transformer
IV. Regulator
V. Filter
VI. Conversion
VII. Three Phase Power Supply

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C21-LW
Inspect and Troubleshoot Power Supplies and Converters
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Troubleshoot power supply; and,
   b. Repair power supply.

2. Student will demonstrate how to:
   a. Troubleshoot power supply; and,
   b. Repair power supply.

3. Instructor will grade students ability to:
   a. Troubleshoot power supply; and,
   b. Repair power supply.

Name:_____ Date:_____

INT-C21
Inspect and Troubleshoot Power Supplies and Converters
Self-Assessment

1. Explain operation of filter.

2. Explain operation of diode.

3. List four types of filter.

4. Explain operation of half wave rectifier.

5. Explain operation of full wave rectifier.

6. What is a bridge rectifier?

7. What is a three phase rectifier?

8. List troubleshooting steps.

9. **List repair steps.**

_____

_____

_____

INT-C21
Inspect and Troubleshoot Power Supplies and Converters
Self-Assessment

1. Attempts to smooth sine wave into a straight line.

2. Allows current to flow in one direction only. Blocks current flow in other direction.

3. Hi pass, low pass, band pass, band reject.

4. Rectifier one half of AC sine wave.

5. Rectifies both halves of sine wave.

6. Diodes arrange in a bridge configuration. (4 sided)

7. Rectifying a three phase supply.

8. Isolate with voltmeter to fault point. That means the diodes are open or shorted.

9. Turn off power. Short all capacitors through a resistor. Cut line, unsolder or unscrew terminal. Remove faulted device. Reverse procedures. Turn on power. Check for proper operations.

INT-C22

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C22

Subject: Instrumentation **Time:** 8 Hrs.

Duty: Maintain Field Instrumentation Devices
Task: Test and Calibrate Control Valve Actuators

Objective(s):

Upon completion of this module the student will be able to:

a. Test control valve actuator; and,
b. Calibrate control valve actuator.

Instructional Materials:

Control valve actuator
Hand tools
MASTER Handout (INT-C22-HO)
MASTER Laboratory Aid (INT-C22-LA)
MASTER Laboratory Worksheet (INT-C22-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C21 "Inspect and Troubleshoot Power Supplies and Converters"

Introduction:

Control valves are used to control flow of fluids. Many types of fluids are used in process industries.

Presentation Outline:

I. Define Control Valve
II. Parts of Control Valve
III. Globe Valve
    A. Single seat
    B. Double seat
IV. Three Way Valve
V. Eccentric Disk Valve
VI. Valve Characteristics
VII. Actuator Selection
VIII. Test Control Valve
IX. Calibrate Control Valve

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C23) dealing with troubleshooting and repairing control valves and positioners.

INT-C22-HO
Test and Calibrate Control Valve Actuators
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test control valve actuator; and,
b. Calibrate control valve actuator.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishers, Latest Edition

Chapter	Title
11	Liquid and Flow Measurements

Module Outline:

I. Define Control Valve
II. Parts of Control Valve
III. Globe Valve
  A. Single seat
  B. Double seat
IV. Three Way Valve
V. Eccentric Disk Valve
VI. Valve Characteristics
VII. Actuator Selection
VIII. Test Control Valve
IX. Calibrate Control Valve

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C22-LW
Test and Calibrate Control Valve Actuators
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. List parts of control valve;
   b. Globe valve-list parts;
      (1) Single seat;
      (2) Double seat;
   c. Three way valve-list parts;
   d. Eccentric disk valve-list parts;
   e. Valve characteristics-list;
   f. Select an actuator;
   g. Test control valves; and,
   h. Calibrate control valves.

2. Student will demonstrate how to:
   a. List parts of control valve;
   b. Globe valve-list parts;
      (1) Single seat;
      (2) Double seat;
   c. Three way valve-list parts;
   d. Eccentric disk valve-list parts;
   e. Valve characteristics-list;
   f. Select an actuator;
   g. Test control valves; and,
   h. Calibrate control valves.

3. Instructor will grade student's ability to:
   a. List parts of control valve;
   b. Globe valve-list parts;
      (1) Single seat;
      (2) Double seat;
   c. Three way valve-list parts;
   d. Eccentric disk valve-list parts;
   e. Valve characteristics-list;
   f. Select an actuator;
   g. Test control valves; and,
   h. Calibrate control valves.

Name:_____ Date:_____

INT-C22
Test and Calibrate Control Valve Actuators
Self-Assessment

1. Define control valve.

2. List parts of a control valve.

3. Globe valve-define.

4. What is a two way valve?

5. What is a four way valve?

6. Define actuator.

7. List procedures for testing a control valve.

8. List procedures to calibrate a control valve.

INT-C22
Test and Calibrate Control Valve Actuators
Self-Assessment Answer Key

1. An in-line device that controls flow.

2. Electromagnetic, plunger, valve (disc or plug-positioned to control flow)

3. Flow regulating valve housing a movable disc and stationery seat in spherical body.

4. Two positions valve-on or off.

5. Used to control a double acting cylinder. Used in heat pump systems to control fecon flow.

6. Mechanism that operators manually the valve.

7. Check input signal. Manually check valve operation.

8. Test at no signal. Test at fall signal. Manually calibrate to these points.

INT-C23

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C23

Subject: **Instrumentation** **Time: 8 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Troubleshoot and Repair Control Valves and Positioners

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot control valve/positioners; and,
b. Repair control valve/positioners.

Instructional Materials:

Control valve positions
Hand tools
MASTER Handout (INT-C23-HO)
MASTER Laboratory Aid (INT-C23-LA)
MASTER Laboratory Worksheet (INT-C23-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C22 "Test and Calibrate Control Valve Actuators"

Introduction:

Control valves are used to control flow of fluids. Many types of fluids are used in process industries.

Presentation Outline:

I. Define Positioner
II. Parts of Positioner
III. Positioner Characteristics
IV. Positioner Selection
V. Troubleshoot Control Valve
VI. Repair Control Valve
VII. Troubleshoot Positioner
VIII. Repair Positioner

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C24) dealing with testing and calibrating controllers.

INT-C23-HO
Troubleshoot and Repair Control Valves and Positioners
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot control valve/positioners; and,
b. Repair control valve/positioners.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishers, Latest Edition:

Chapter	Title
11	Liquid and Flow Measurements

Module Outline:

I. Define Positioner
II. Parts of Positioner
III. Positioner Characteristics
IV. Positioner Selection
V. Troubleshoot Control Valve
VI. Repair Control Valve
VII. Troubleshoot Positioner
VIII. Repair Positioner

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C23-LW
Troubleshoot and Repair Control Valves and Positioners
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Identify the parts of a positioner;
   b. Select a positioner;
   c. Troubleshoot control valve;
   d. Repair a control valve;
   e. Troubleshoot a positioner; and,
   f. Repair a positioner.

2. Student will demonstrate how to:
   a. Identify the parts of a positioner;
   b. Select a positioner;
   c. Troubleshoot control valve;
   d. Repair a control valve;
   e. Troubleshoot a positioner; and,
   f. Repair a positioner.

3. Instructor will grade student's ability to:
   a. Identify the parts of a positioner;
   b. Select a positioner;
   c. Troubleshoot control valve;
   d. Repair a control valve;
   e. Troubleshoot a positioner; and,
   f. Repair a positioner.

Name:_____ Date:_____

INT-C23-HO
Troubleshoot and Repair Control Valves and Positioners
Self-Assessment

1. Define positioner.

_____
_____
_____

2. List procedures for troubleshooting.

_____
_____
_____

3. List procedures for troubleshooting a control valve.

_____
_____
_____

4. List procedures to repair a control valve.

_____
_____
_____

INT-C23
Troubleshoot and Repair Control Valves and Positioners
Self-Assessment Answer Key

1. The controlled motion operates in accordance with instruction which specify next required position. This position may be converted into a signal.

2. Check for signal output. Check for transducer operation.

3. Check for signal output. Check for proper opening of control valve.

4. Study vendor manual on repair. Turn off flow through valve or bypass valve. Make repair. Check for leaks. Check for proper operation. Place back into service.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C24

Subject: **Instrumentation** **Time: 20 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Test and Calibrate Controllers

Objective(s):

Upon completion of this module the student will be able to:
a. Test controllers; and,
b. Calibrate controllers.

Instructional Materials:

Controllers
MASTER Handout (INT-C24-HO)
MASTER Laboratory Aid (INT-C24-LA)
MASTER Laboratory Worksheet (INT-C24-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C23 "Troubleshoot and Repair Control Valves and Positioners"

Introduction:

Controllers are smart devices that makes decisions based on the conditions of inputs and the way it is programmed. Controllers are similar in function to the brains that people use to control their actions. This module deals with testing and calibrating controllers.

Presentation Outline:

I. Define Controller
II. On/Off Control
III. Proportional Control
IV. Integral Control
V. Derivative Control
VI. Testing Procedures
VII. Calibration Procedure

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C25) dealing with troubleshooting and repairing local controllers.

INT-C24-HO
Test and Calibrate Controllers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test controllers; and,
b. Calibrate controllers.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
8	Controls

Module Outline:

I. Define Controller
II. On/Off Control
III. Proportional Control
IV. Integral Control
V. Derivative Control
VI. Testing Procedures
VII. Calibration Procedure

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C24-LW
Test and Calibrate Controllers
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Define controller;
   b. Identify on/off control;
   c. Identify proportional control;
   d. Identify integral control;
   e. Identify derivative control;
   f. Apply testing procedures; and,
   g. Apply calibration procedure.

2. Students will demonstrate how to:
   a. Define controller;
   b. Identify on/off control;
   c. Identify proportional control;
   d. Identify integral control;
   e. Identify derivative control;
   f. Apply testing procedures; and,
   g. Apply calibration procedure.

3. Instructor will grade student's ability to:
   a. Define controller;
   b. Identify on/off control;
   c. Identify proportional control;
   d. Identify integral control;
   e. Identify derivative control;
   f. Apply testing procedures; and,
   g. Apply calibration procedure.

Name:_____ Date:_____

INT-C24
Test and Calibrate Controllers
Self-Assessment

1. In controller lines, the UPS is used to _____.
   a. Control ambient temperature
   b. Maintain constant power
   c. Regulate input signal
   d. Regulate output signal

2. A good practice in performing pneumatic controller tests is _____.
   a. Increasing pneumatic pressure slowly
   b. Maintaining correct AC polarity
   c. Keeping low level lines with 2 inch is high level lines
   d. Removing shielding on all lines

3. A controller with a drifting displays maybe a problem with _____.
   a. Output PC boards
   b. Output modules
   c. Field output devices
   d. Input PC boards

4. An RTD signal to a controller can be simulated by _____.
   a. Resistance decade box
   b. Voltmeter
   c. Ammeter
   d. LVDT

5. A controller has no display, does not respond to PV, therefore, cause may be _____.
   a. Bed grouting
   b. Bed filtering
   c. Bad power supply
   d. Bad fiche output device

6. Most controllers operate satisfactory if the voltage supply is plus or minus _____ percent.
   a. 15
   b. 10
   c. 20
   d. 25

INT-C24
Test and Calibrate Controllers
Self-Assessment Answer Key

1. b
2. a
3. d
4. a
5. c
6. b

INT-C25

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C25

Subject: **Instrumentation** **Time: 22 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Troubleshoot and Repair Local Controllers

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot controllers; and,
b. Repair controllers.

Instructional Materials:

Controllers
MASTER Handout (INT-C25-HO)
MASTER Laboratory Aid (INT-C25-LA)
MASTER Laboratory Worksheet (INT-C25-LW)
MASTER Performance Measure (INT-C25-PM)

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C24 "Test and Calibrate Controllers"

Introduction:

Controllers are smart devices that makes decisions based on the conditions of inputs and the way it is programmed. Controllers are similar to production to the brains that people use to contact their actions. This module deals with troubleshooting and repairing local controllers.

Presentation Outline:

I. Troubleshooting Principles
II. Types of Controllers
III. Controller Parts
IV. Troubleshooting Controllers
V. Repair Controllers

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C26) dealing with troubleshooting and repairing electronic computing relays.

INT-C25-HO
Troubleshoot and Repair Local Controllers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot controllers; and,
b. Repair controllers.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
8	Controls

Module Outline:

I. Troubleshooting Principles
II. Types of Controllers
III. Controller Parts
IV. Troubleshooting Controllers
V. Repair Controllers

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C25-LW
Troubleshoot and Repair Local Controllers
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Use troubleshooting principles;
   b. Identify types of controllers;
   c. Identify and list controller parts;
   d. Troubleshoot controllers; and,
   e. Repair controllers.

2. Student will demonstrate how to:
   a. Use troubleshooting principles;
   b. Identify types of controllers;
   c. Identify and list controller parts;
   d. Troubleshoot controllers; and,
   e. Repair controllers.

3. Instructor will grade student's ability to:
   a. Use troubleshooting principles;
   b. Identify types of controllers;
   c. Identify and list controller parts;
   d. Troubleshoot controllers; and,
   e. Repair controllers.

Name:_____ Date:_____

INT-C25
Troubleshoot and Repair Local Controllers
Self-Assessment

1. Polarity is important when making _____ instrument connections, but not _____ connections.
   a. AC, DC
   b. Single phase, three phase
   c. Three phase, single phase
   d. DC, AC

2. Controller failures caused by extremes of _____ are often intermittent and hard to diagnose.
   a. Abient temperature
   b. Pressure
   c. Flow
   d. Level

3. In a shared display on a contrast panel of a digital controllers the value is _____.
   a. At the top
   b. Indicated by statue lights
   c. At the bottom
   d. On the left

4. Which controller would be used to prevent over heating a work load while not slowing the process?
   a. Feedforward
   b. Feedback
   c. Ratio
   d. Auctioning

5. Ratio of on time to cycle time is _____.
   a. Response time
   b. Proportional time
   c. Reset time
   d. Duty cycle

6. Which controller mode is adjusted by adjusting by changing its repeats per minute?
   a. Internal
   b. Proportional
   c. Rate
   d. Derivative

7. The purpose of dead band in an on/off controller is _____.
   a. Reduce cycling
   b. Increase accuracy
   c. Increase sensitivity
   d. Increase cycling

8. The most common controller input is _____.
   a. 3 to 15 ma
   b. 4 to 20 ma
   c. 0 to 10 vdc
   d. 4 to 20 vdc

9. The adjustment of a controller's modes are called _____.
   a. Coordination
   b. Tuning
   c. Testing
   d. Calibrating

INT-C25
Troubleshoot and Repair Local Controllers
Self-Assessment Answer Key

1. d
2. a
3. b
4. d
5. d
6. a
7. a
8. b
9. b

INSTRUMENTATION SERIES

MASTER Technical Module No INT-C26

Subject: Instrumentation **Time: 9 Hrs.**

Duty: Maintain Field Instrumentation Devices
Task: Troubleshoot and Repair Electronic Computing Relays

Objective(s):

Upon completion of this module the student will be able to:

a. Troubleshoot electronic computing relays; and,
b. Repair electronic computing relays.

Instructional Materials:

Electronic computing relay
MASTER Handout (INT-C26-HO)
MASTER Laboratory Aid (INT-C26-LA)
MASTER Laboratory Worksheet (INT-C26-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C25 "Troubleshoot and Repair Local Controllers"

Introduction:

Relays allow one to control a large amount of electrical properties bu controlling a small amount of voltage and current. This increase makes the relay an important of controls.

Presentation Outline:

I. Define Electronic Computing Relay
II. List Parts of Electronic Computing Relay
III. List Operation of Electronic Computing Relay
IV. Troubleshoot Electronic Computing Relay
V. Repair Electronic Computing Relay

Practical Application:

Student will:
1. Troubleshoot electronic computing relay; and,
2. Repair electronic computing relay.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C27) dealing with testing and calibrating gas analyzers.

INT-C26-HO
Troubleshoot and Repair Electronic Computing Relays
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot electronic computing relays; and,
b. Repair electronic computing relays.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
8	Control

Module Outline:

I. Define Electronic Computing Relay
II. List Parts of Electronic Computing Relay
III. List Operation of Electronic Computing Relay
IV. Troubleshoot Electronic Computing Relay
V. Repair Electronic Computing Relay

INT-C26-LA
Troubleshoot and Repair Electronic Computing Relays
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Troubleshoot electronic computing relay; and,
   c. Repair electronic computing relay.

INT-C26-LW
Troubleshoot and Repair Electronic Computing Relays
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Troubleshoot electronic computing relay; and,
   b. Repair electronic computing relay.

2. Student will demonstrate how to:
   a. Troubleshoot electronic computing relay; and,
   b. Repair electronic computing relay.

3. Instructor will grade student's ability to:
   a. Troubleshoot electronic computing relay; and,
   b. Repair electronic computing relay.

Name:_____ Date:_____

INT-C26
Troubleshoot and Repair Electronic Computing Relays
Self-Assessment

1. A set of relay contacts labeled NO will be closed when the relay coil is _____.

2. The label CR3 refers to _____.

3. A relay marked TDC is _____.

4. List steps to troubleshoot electronic computing relay.
_____
_____
_____

5. List steps to repair electronic computing relay.
_____
_____
_____

INT-C26
Troubleshoot and Repair Electronic Computing Relays
Self-Assessment Answer Key

1. Not energized.

2. Relay coil #3.

3. Time delay on closing.

4. Use VOM and scope test equipment. Make sure that each have high input impedance. Check operation of device.

5. Turn off power. Repair in steps. Replace if not able to repair.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C27

Subject: **Instrumentation** **Time: 15 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Test and Calibrate Gas Analyzers

Objective(s):

Upon completion of this module the student will be able to:
a. Test gas analyzers; and,
b. Calibrate gas analyzers.

Instructional Materials:

Gas Analyzers
MASTER Handout (INT-C27-HO)
MASTER Laboratory Aid (INT-C27-LA)
MASTER Laboratory Worksheet (INT-C27-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C26 "Troubleshoot and Repair Electronic Computing Relays"

Introduction:

Analyzers are smart devices. Analyzers are used to analyze conductivity, absorption, pH, concentration, density, viscosity, combustible, and specific gravity. This mode deals with gas analyzers.

Presentation Outline:

I. Define Gas Analyzer
II. Conductivity
III. Absorption
IV. Concentration
V. Density
VI. Combustibility
VII. Parts for a Gas Analyzer
VIII. Gas Analyzer
IX. Repair Gas Analyzer

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C28) dealing with testing and calibrating air analyzers.

INT-C27-HO
Test and Calibrate Gas Analyzers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test gas analyzers; and,
b. Calibrate gas analyzers.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
13	Analysis

Module Outline:

I. Define Gas Analyzer
II. Conductivity
III. Absorption
IV. Concentration
V. Density
VI. Combustibility
VII. Parts for a Gas Analyzer
VIII. Gas Analyzer
IX. Repair Gas Analyzer

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C27-LW
Test and Calibrate Gas Analyzers
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Test gas analyzers; and,
   b. Calibrate gas analyzers.

2. Student's will demonstrate how to:
   a. Test gas analyzers; and,
   b. Calibrate gas analyzers.

3. Instructor will grade student's ability to:
   a. Test gas analyzers; and,
   b. Calibrate gas analyzers.

Name:_____ Date:_____

INT-C27
Test and Calibrate Gas Analyzers
Self-Assessment

1. Conductivity probes measure current passing through liquid containing _____ particles.
   a. Small
   b. Large
   c. Scattered
   d. Ionized

2. Stack gas monitoring can be continuous or _____ testing.
   a. Intermittent
   b. Grab sample
   c. Sporadic
   d. Periodic

3. Inductive and _____ should be installed with measuring surface completely submerged in the process liquid.
   a. Resistive
   b. Capacitive
   c. Power
   d. Electrode

4. Most optical analyzers operate by measuring the amount of light a device _____.
   a. Reflects
   b. Diffuses
   c. Absorbs
   d. Filters

5. The operation of a capacity analyzer depends on the expansion or contraction of the gas in the _____.
   a. Sample beam
   b. Laser
   c. Filter
   d. Detector

INT-C27
Test and Calibrate Gas Analyzers
Self-Assessment Answer Key

1. d
2. b
3. d
4. c
5. d

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C28

Subject: **Instrumentation** **Time: 15 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Test And Calibrate Air Analyzers

Objective(s):

Upon completion of this module the student will be able to:
a. Test air analyzer; and,
b. Calibrate air analyzer.

Instructional Materials:

Air analyzer
MASTER Handout (INT-C28-HO)
MASTER Laboratory Aid (INT-C28-LA)
MASTER Laboratory Worksheet (INT-C28-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C2 "Troubleshoot and Repair Pressure, Level, Flow, and Temperature Switches"

Introduction:

Analyzers are smart devices. Analyzers are used to analyze conductivity, absorption, pH, concentration, density, viscosity, combustible, and specific gravity. This module deals with air analyzer.

Presentation Outline:

I. Define Air Analyzer
II. Major Parts of Air Analyzer
III. Probes Used with Air Analyzer
IV. Testing Air Analyzer
V. Calibrating Air Analyzers

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C29) dealing with testing and calibrating water analyzers.

INT-C28-HO
Test and Calibrate Air Analyzers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test air analyzer; and,
b. Calibrate air analyzer.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
13	Analysis

Module Outline:

I. Define Air Analyzer
II. Major Parts of Air Analyzer
III. Probes Used with Air Analyzer
IV. Testing Air Analyzer
V. Calibrating Air Analyzers

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C28-LW
Test and Calibrate Air Analyzers
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Test air analyzer; and,
   b. Calibrate air analyzer.

2. Student will demonstrate how to:
   a. Test air analyzer; and,
   b. Calibrate air analyzer.

3. Instruction will grade student's ability to:
   a. Test air analyzer; and,
   b. Calibrate air analyzer.

Name:_____ Date:_____

INT-C28
Test and Calibrate Air Analyzers
Self-Assessment

1. An oxygen analyze will indicate a reduced oxygen concentration if the _____.
   a. Temperature increases
   b. Flow rate decreases
   c. Pressure increase
   d. Pressure decreases

2. The operation of a paramagnetic analyzer depends on the magnetic properties of _____.
   a. Carbon monoxide
   b. Hydrogen
   c. Carbon dioxide
   d. Oxygen

3. An analyzer that takes the sample and puts it into the sensor cell is called a(n) _____ analyzer.
   a. Extractive
   b. Paramagnetic
   c. Electrochemical
   d. Pressure

4. Concentrations of carbon monoxide and carbon dioxide can be measured most accurately by _____ analyzers.
   a. Extractive
   b. Electrochemical
   c. Infrared absorption
   d. Pressure

INT-C28
Test and Calibrate Air Analyzers
Self-Assessment Answer Key

1. d
2. d
3. a
4. c

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C29

Subject: Instrumentation **Time: 15 Hrs.**

Duty: Maintain Field Instrumentation Devices
Task: Test and Calibrate Water Analyzers

Objective(s):

Upon completion of this module the student will be able to:
a. Test water analyzers; and,
b. Calibrate water analyzers.

Instructional Materials:

Water Analyzer
MASTER Handout (INT-C29-HO)
MASTER Laboratory Aid (INT-C29-LA)
MASTER Laboratory Worksheet (INT-C29-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C28 "Test and Calibrate Air Analyzers"

Introduction:

Analyzers are smart devices. Analyzers are used to analyze conductivity, absorption, pH, concentration, density, viscosity, combustible, and specific gravity. This module deals with water analyzers.

Presentation Outline:

I. Define Water Analyzer
II. List Major Componènts of Water Analyzer
III. Properties to Be Measured
IV. Testing Procedure
V. Calibration Procedure

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C30) dealing with troubleshooting servo valves.

INT-C29-HO
Test and Calibrate Water Analyzers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Test water analyzers; and,
b. Calibrate water analyzers.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	**Title**
13	Analysis

Module Outline:

I. Define Water Analyzer
II. List Major Components of Water Analyzer
III. Properties to Be Measured
IV. Testing Procedure
V. Calibration Procedure

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C29-LW
Test and Calibrate Water Analyzers
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Test water analyzers; and,
   b. Calibrate water analyzers.

2. Student will demonstrate how to:
   a. Test water analyzers; and,
   b. Calibrate water analyzers.

3. Instructor will grade student's ability to:
   a. Test water analyzers; and,
   b. Calibrate water analyzers.

Name:_____ Date:_____

INT-C29
Test and Calibrate Water Analyzers
Self-Assessment

1. The purpose of the ultrasonic device in a submersion electrode holder is to _____.
   a. Increase flow
   b. Reduce calibration time
   c. Clean the electrodes
   d. Prevent tip breakage

2. Which of the following pH values indicates a basic solution?
   a. 3
   b. 7
   c. 11
   d. 2

3. Standard reference temperature for measuring pH is _____.
   a. 0°C
   b. 25°C
   c. 32°F
   d. 0°F

4. Several factors affect process liquids. These are _____, _____, and _____.
   a. Temperature, pressure flow
   b. Pressure, temperature, contaminate
   c. Pressure, chemical concentration, flow
   d. Temperature, contaminate, chemical concentrate

INT-C29
Test and Calibrate Water Analyzers
Self-Assessment Answer Key

1. c
2. c
3. b
4. d

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C30

Subject: Instrumentation **Time: 7 Hrs.**

Duty: Maintain Field Instrumentation Devices
Task: Troubleshoot Servo Valves

Objective(s):

Upon completion of this module the student will be able to troubleshoot servo valves.

Instructional Materials:

Servo valve
DMM
MASTER Handout (INT-C30-HO)
MASTER Laboratory Aid (INT-C30-LA)
MASTER Laboratory Worksheet (INT-C30-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C29 "Test and Calibrate Water Analyzers"

Introduction:

Servo valves are position sensitive. Knowing the exact position is important to maintain consistent product. We will study servo valves in this module.

Presentation Outline:

I. Define Servo
II. Define Valve
III. Define Servo Valve
IV. Operation of Servo Valve
V. Maintenance of Servo Valve
VI. Troubleshoot Servo Valve

Practical Application:

The student will troubleshoot servo valve.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C31) dealing with calibrating servo valves.

INT-C30-HO
Troubleshoot Servo Valves
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to troubleshoot servo valves.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
14	Control Valves

Module Outline:

I. Define Servo
II. Define Valve
III. Define Servo Valve
IV. Operation of Servo Valve
V. Maintenance of Servo Valve
VI. Troubleshoot Servo Valve

INT-C30-LA
Troubleshoot Servo Valves
Attachment 2: **MASTER** Laboratory Aid

1, Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Troubleshoot servo valve.

INT-C30-LW
Troubleshoot Servo Valves
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to troubleshoot servo valves.

2. Student will demonstrate how to troubleshoot servo valves.

3. Instructor will grade student's ability to troubleshoot servo valves.

Name:_____ Date:_____

INT-C30
Troubleshoot Servo Valves
Self-Assessment

1. Define servo.

_____
_____
_____

2. Define valve.

_____
_____
_____

3. Define servo valve.

_____
_____
_____

4. List maintenance steps of a servo valve.

_____
_____
_____

5. List troubleshoot steps of a servo valve.

_____
_____
_____

INT-C30
Troubleshoot Servo Valves
Self-Assessment Answer Key

1. A feedback control system.

2. An in-line device that controls flow.

3. An automatic control system using feedback that control position.

4. Check movement. Make sure there are physical restrictions.

5. Check physical position. Adjust physical position. Check feedback signal.

INT-C31

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C31

Subject: Instrumentation **Time: 7 Hrs.**

Duty: Maintain Field Instrumentation Devices
Task: Calibrate Servo Valves

Objective(s):

Upon completion of this module the student will be able to:

a. Calibrate servo valves;
b. Define servo valve; and,
c. Identify servo valve.

Instructional Materials:

Servo valve
Calibration test equipment
MASTER Handout (INT-C31-HO)
MASTER Laboratory Aid (INT-C31-LA)
MASTER Laboratory Worksheet (INT-C31-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C30 "Troubleshoot Servo Valves"

Introduction:

Servo valves are unique. These valves are position sensitive. An electrical signal causes the valve to advance a precise small increment. They are useful for precise measurements.

Presentation Outline:

I. Define Valve
II. Define Servo
III. Define Servo Valve
IV. Parts of Servo Valve
V. How Servo Valve Works
VI. Servo Valve Calibration
VII. Servo Valve Maintenance

Practical Application:

Student will calibrate a servo valve.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C32) dealing with testing and cleaning video display unit.

INT-C31-HO
Calibrate Servo Valves
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Calibrate servo valves;
b. Define servo valve; and,
c. Identify servo valve.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition

Chapter	Title
14	Control Valves

Module Outline:

I. Define Valve
II. Define Servo
III. Define Servo Valve
IV. Parts of Servo Valve
V. How Servo Valve Works
VI. Servo Valve Calibration
VII. Servo Valve Maintenance

INT-C31-LA
Calibrate Servo Valves
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Calibrate a servo valve.

INT-C31-LW
Calibrate Servo Valves
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Calibrate servo valves;
   b. Define servo valve; and,
   c. Identify servo valve.

2. Student will demonstrate how to:
   a. Calibrate servo valves;
   b. Define servo valve; and,
   c. Identify servo valve.

3. Instructor will grade student's ability to:
   a. Calibrate servo valves;
   b. Define servo valve; and,
   c. Identify servo valve.

Name:_____ Date:_____

INT-C31
Calibrate Servo Valves
Self-Assessment

1. Define valve.

2. Define servo.

3. Define servo valve.

4. List steps for servo valve calibration.

5. List steps for servo valve maintenance.

INT-C31
Calibrate Servo Valves
Self-Assessment Answer Key

1. An in-line device that controls flow.

2. A feedback control system.

3. An automatic control system using feedback that controls position.

4. Check movement. Adjust movement. Check signal. Adjust to desired signal. Recheck movement. Adjust if necessary.

5. Check movement. Make sure that there are no physical restrictions to movement.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C32

Subject: Instrumentation **Time:** 12 Hrs.

Duty: Maintain Field Instrumentation Devices
Task: Test And Clean Video Display Unit

Objective(s):

Upon completion of this module the student will be able to:
a. Clean video display unit; and,
b. Test video display unit.

Instructional Materials:

Video display unit
Oscilloscope
DMM
MASTER Handout (INT-C32-HO)
MASTER Laboratory Aid (INT-C32-LA)
MASTER Laboratory Worksheet (INT-C32-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C31 "Calibrate Servo Valves"

Introduction:

With today's technology, video display units are an important factor. There is a saying: "A picture is worth a thousand words." This relates to video display units.

Presentation Outline:

I. Clean Video Display Unit
II. Test Video Display Unit

Practical Application:

Student will:
1. Clean video display unit; and,
2. Test video display unit.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C33) dealing with checking and adjusting video display unit.

INT-C32-HO
Test and Clean Video Display Unit
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Clean video display unit; and,
b. Test video display unit.

Module Outline:

I. Clean Video Display Unit
II. Test Video Display Unit

INT-C32-LA
Test and Clean Video Display Unit
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   a. Insure proper tools and materials are available for project completion;
   b. Insure proper techniques and safety procedures are followed in completing the project; and,
   c. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   a. Clean video display unit; and,
   b. Test video display unit.

INT-C32-LW
Test and Clean Video Display Unit
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Clean video display unit; and,
   b. Test video display unit.

2. Student will demonstrate how to:
   a. Clean video display unit; and,
   b. Test video display unit.

3. Instructor will grade student's ability to:
   a. Clean video display unit; and,
   b. Test video display unit.

Name:_____ Date:_____

INT-C32
Test and Clean Video Display Unit
Self-Assessment

1. List steps to clean video display unit.

_____ _____
_____
_____

2. List steps to test video display unit.

_____
_____
_____

INT-C32
Test and Clean Video Display Unit
Self-Assessment Answer Key

1. Use anti-static material to clean video display unit. Follow vendors recommendations.

2. Test for proper resolution. Test for contrast. Test for proper vertical and horizontal position.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C33

Subject: **Instrumentation** **Time: 6 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Check and Adjust Video Display Unit

Objective(s):

Upon completion of this module the student will be able to:
a. Check video display unit; and,
b. Adjust video display unit.

Instructional Materials:

Oscilloscope
DMM
Video display unit
MASTER Handout (INT-C33-HO)
MASTER Laboratory Aid (INT-C33-LA)
MASTER Laboratory Worksheet (INT-C33-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C32 "Test and Clean Video Display Unit"

Introduction:

With today's technology, video display units are an important factor. There is a saying: "A picture is worth a thousand words." This relates to video display units.

Presentation Outline:

I. Check Video Display Unit
II. Adjust Video Display Unit

Practical Application:

Student will:
1. Check video display unit; and,
2. Adjust video display unit.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C34) dealing with designing, specifying, and configuring smart field devices, i.e., transmitters and valves.

INT-C33-HO
Check and Adjust Video Display Unit
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Check video display unit; and,
b. Adjust video display unit.

Module Outline:

I. Check Video Display Unit
II. Adjust Video Display Unit

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Check video display unit; and,
   c. Adjust video display unit.

INT-C33-LW
Check and Adjust Video Display Unit
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Check video display unit; and,
   b. Adjust video display unit.

2. Student will demonstrate how to:
   a. Check video display unit; and,
   b. Adjust video display unit.

3. Instructor will grade student's ability to:
   a. Check video display unit; and,
   b. Adjust video display unit.

Name:_____ Date:_____

INT-C33
Check and Adjust Video Display Unit
Self-Assessment

1. List steps to check video display unit.

_____
_____
_____

2. List steps to adjust video display unit.

_____
_____
_____

INT-C33
Check and Adjust Video Display Unit
Self-Assessment Answer Key

1. Make sure line of sight is directly in front of video display. Check for proper height and width of display.

2. Adjust for proper height and width. Adjust brightness to suit individual using video display unit. Adjust for proper position of display. Adjust focus. Adjust contrast.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C34

Subject: **Instrumentation** **Time: 24 Hrs.**

Duty: **Maintain Field Instrumentation Devices**
Task: Design, Specify and Configure Smart Field Devices, i.e., Transmitters and Valves

Objective(s):

Upon completion of this module the student will be able to:
a. Configure smart transmitters;
b. Configure valve operation;
c. Specify smart transmitters; and,
d. Design smart transmitters parameters.

Instructional Materials:

Smart transmitter
Smart transmitter calibrator, such as the Rosemount 260
MASTER Handout (INT-C34-HO)
MASTER Laboratory Aid (INT-C34-LA)
MASTER Laboratory Worksheet (INT-C34-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C33 "Check and Adjust Video Display Unit"

Introduction:

Smart transmitters are microprocessor controlled. Microprocessors are needed to predict performance based on trends for modern plants.

Presentation Outline:

I. Configure Smart Transmitters
II. Configure Valve Operation
III. Specify Smart Transmitters
IV. Design Smart Transmitters Parameters

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C35) dealing with operating control systems including single element, cascade, ratio, and feedforward.

INT-C34-HO
Design, Specify and Configure Smart Field Devices, i.e., Transmitters and Valves
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Configure smart transmitters;
b. Configure valve operation;
c. Specify smart transmitters; and,
d. Design smart transmitters parameters.

Reading Assignments:

Rosemount Vendor Manual-Rosemount 260 Smart Transmitter (Entire Pamphlet), Latest Edition

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Module Outline:

I. Configure Smart Transmitters
II. Configure Valve Operation
III. Specify Smart Transmitters
IV. Design Smart Transmitters Parameters

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C34-LW
Design, Specify and Configure Smart Field Devices, i.e., Transmitters and Valves
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:

Practical Exercise **CALIBRATING A SMART TRANSMITTER**		
List answers and steps.	YES	NO
Initiate communications with the transmitter		
What is the current tag name of the transmitter?		
Change the tag name to 5TT204-2.		
What is the temperature range of the transmitter?		
Change the temperature range to 0-300 degree C.		
What is the damping time of the transmitter?		
Change the damping time to 2.00 sec.		
What is the current temperature reading and the resultant ma output? Record values; PV _____ deg C, Output = _____ ma		
Change the tag name back to First Try.		
Change the range back to 0-400 degrees C.		
Change the damping back to 2.00 sec.		

2. Student will practice:

Practical Exercise CALIBRATING A SMART TRANSMITTER		
List answers and steps.	YES	NO
Initiate communications with the transmitter		
What is the current tag name of the transmitter?		
Change the tag name to 5TT204-2.		
What is the temperature range of the transmitter?		
Change the temperature range to 0-300 degree C.		
What is the damping time of the transmitter?		
Change the damping time to 2.00 sec.		
What is the current temperature reading and the resultant ma output? Record values; PV _____ deg C. Output = _____ ma		
Change the tag name back to First Try.		
Change the range back to 0-400 degrees C.		
Change the damping back to 2.00 sec.		

Name:_____ Date:_____

INT-C34
Design, Specify and Configure Smart Field Devices, i.e., Transmitters and Valves
Self-Assessment

Practical Exercise **CALIBRATING A SMART TRANSMITTER**		
List answers and steps.	YES	NO
Initiate communications with the transmitter		
What is the current tag name of the transmitter?		
Change the tag name to 5TT204-2.		
What is the temperature range of the transmitter?		
Change the temperature range to 0-300 degree C.		
What is the damping time of the transmitter?		
Change the damping time to 2.00 sec.		
What is the current temperature reading and the resultant ma output? Record values: PV _____ deg C. Output = _____ ma		
Change the tag name back to First Try.		
Change the range back to 0-400 degrees C.		
Change the damping back to 2.00 sec.		

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C35

Subject: Instrumentation **Time: 21 Hrs.**

Duty: Maintain Field Instrumentation Devices
Task: Operate Control Systems Including Single Element, Cascade, Ratio, and Feedforward

Objective(s):

Upon completion of this module the student will be able to:

a. Operate single element control system;
b. Operate cascade element control system;.
c. Operate ratio element control system; and,
d. Operate feedforward element control systems.

Instructional Materials:

Single element control system
Cascade element control system
Ratio element control system
Feedforward element control systems
MASTER Handout (INT-C35-HO)
MASTER Laboratory Aid (INT-C35-LA)
MASTER Laboratory Worksheet (INT-C35-LW)

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C34 "Design, Specify and Configure Smart Field Devices, i.e., Transmitters and Valves"

Introduction:

Control systems are the decision making devices in as instrumentation loop. There are several control schemes. In this module we look at each scheme.

Presentation Outline:

I. Single Element Control System
II. Cascade Element Control System
III. Ratio Element Control System
IV. Feedforward Element Control Systems

Practical Application:

Student will operate:
1. Single element control system;
2. Cascade element control system;
3. Ratio element control system; and,
4. Feedforward element control systems.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-C36) dealing with troubleshooting and repairing analyzers.

INT-C35-HO
Operate Control Systems Including Single Element, Cascade, Ratio, and Feedforward
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Operate single element control system;
b. Operate cascade element control system;.
c. Operate ratio element control system; and,
d. Operate feedforward element control systems.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
8	Controls

Module Outline:

I. Single Element Control System
II. Cascade Element Control System
III. Ratio Element Control System
IV. Feedforward Element Control Systems

INT-C35-LA
Operate Control Systems Including Single Element, Cascade, Ratio, and Feedforward
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   a. Operate single element control system;
   b. Operate cascade element control system;
   c. Operate ratio element control system; and,
   d. Operate feedforward element control systems.

INT-C35-LW
Operate Control Systems Including Single Element, Cascade, Ratio, and Feedforward
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Operate single element control system;
   b. Operate cascade element control system;
   c. Operate ratio element control system; and,
   d. Operate feedforward element control systems.

2. Student will demonstrate how to:
   a. Operate single element control system;
   b. Operate cascade element control system;
   c. Operate ratio element control system; and,
   d. Operate feedforward element control systems.

3. Instructor will grade student's ability to:
   a. Operate single element control system;
   b. Operate cascade element control system;
   c. Operate ratio element control system; and,
   d. Operate feedforward element control systems.

INT-C36

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-C36

Subject: Instrumentation **Time:** 10 Hrs.

Duty: Maintain Field Instrumentation Devices
Task: Troubleshoot and Repair Analyzers

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot analyzers; and,
b. Repair analyzers.

Instructional Materials:

Analyzer
MASTER Handout (INT-C36-HO)
MASTER Laboratory Aid (INT-C36-LA)
MASTER Laboratory Worksheet (INT-C36-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C35 "Operate Control Systems Including Single Element, Cascade, Ratio, and Feedforward"

Introduction:

Analyzers are smart devices. Analyzers are used to analyze conductivity, absorption, pH, concentration, density, viscosity, combustible, and specific gravity. This mode deals with analyzers.

Presentation Outline:

I. Troubleshooting Procedure
II. Repair Procedures

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-D1) dealing with organizing documents and drawings required on the job.

INT-C36-HO
Troubleshoot and Repair Analyzers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot analyzers; and,
b. Repair analyzers.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
13	Analysis

Module Outline:

I. Troubleshooting Procedure
II. Repair Procedures

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C36-LW
Troubleshoot and Repair Analyzers
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Troubleshoot analyzers; and,
   b. Repair analyzers.

2. Student will demonstrate how to:
   a. Troubleshoot analyzers; and,
   b. Repair analyzers.

3. Instructor will grade student's ability to:
   a. Troubleshoot analyzers; and,
   b. Repair analyzers.

Name:_____ Date:_____

INT-C36
Troubleshoot and Repair Analyzers
Self-Assessment

1. Define analyzer.

_____
_____
_____

2. Define troubleshooting procedure for a analyzer.

_____
_____
_____

3. List repair steps for an analyzer.

_____
_____
_____

INT-C36
Troubleshoot and Repair Analyzers
Self-Assessment Answer Key

1. A test instrument that can measure different variable either simultaneously or sequentially.

2. Check each variable for proper value. Adjust each variable to proper value. Check sequence. Adjust sequence if necessary.

3. Repair section for one variable. Be sure that section works properly. Repair next section. Make sure that section works properly. Repeat procedure until all sections are working properly.

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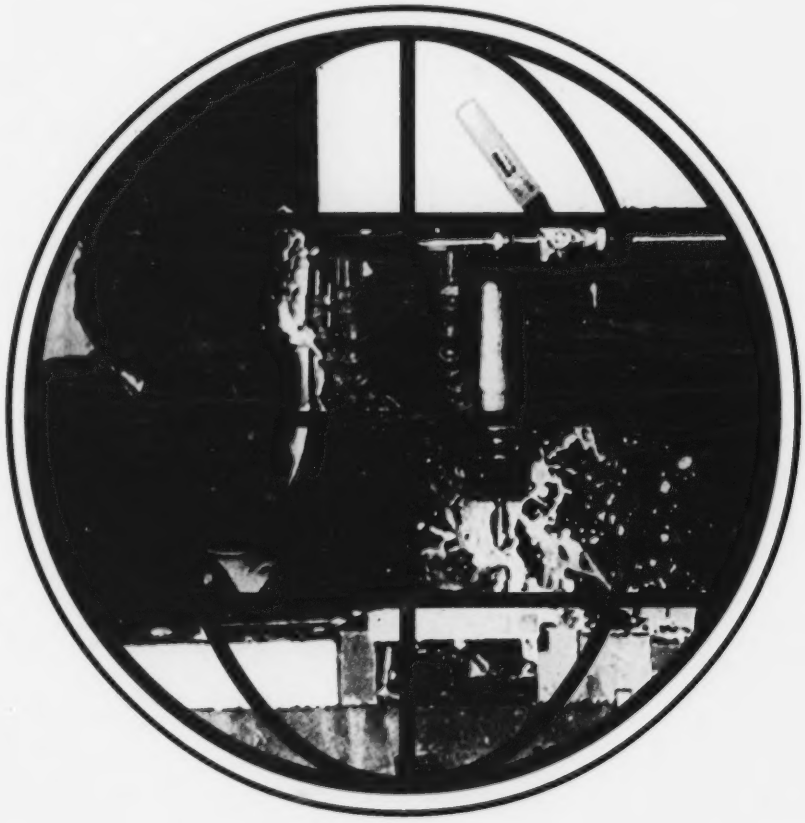

Instrumentation Series

INSTRUCTOR'S HANDBOOK

DUTIES D THROUGH H

722

Supported by the National Science Foundation's Advanced Technological Education Program

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and repair transmitters	C-12 Test different field sensing elements, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Calibrate transmitters	C-15 Tune controllers: pneumatic and electronic	C-16 Trouble-shoot and repair plant computing systems relating to process controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and repair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and configure smart field devices, i.e., transmitters and valves	C-35 Operate control systems including single element, cascade, ratio, and feedforward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Determine proper tools, equipment, and materials to perform the job	D-3 Coordinate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment isolation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibration procedures	D-8 Follow specifications and procedures	D-9 Perform algebraic operations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibration data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise procedures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Application of ISA/IEC standards	F-5 Understand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Understand personal computers	F-10 Attend on-going safety training courses	F-11 Participate in plant related training	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

723

Duty D

724

INT-D1

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-D1

Subject: Instrumentation **Time: 3 Hrs.**

Duty: Organize Work Routines
Task: Organize Documents and Drawings Required on the Job

Objective(s):

Upon completion of this module the student will be able to:

a. Organize and secure P&ID drawing;
b. Organize and secure calibration vendor information;
c. Organize and secure calibration blank forms; and,
d. Organize and secure previous calibration sheets.

Instructional Materials:

Calibrations blank form
Previous calibration sheets
MASTER Handout (INT-D1-HO)
MASTER Laboratory Aid (INT-D1-LA)
MASTER Laboratory Worksheet (INT-D1-LW)

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-C36 "Test and Repair Analyzers"

Introduction:

Proper documentation for an instrumentation technician is very important. Calibration must be traced to a national standard.

Presentation Outline:

I. P&ID Drawings
II. Calibration Sheets Format
III. Completed Calibration Sheets Format
IV. Calibration Vendor Information

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-D2) dealing with determining proper tools/equipment/materials to perform the job.

INT-D1-HO
Organize Documents and Drawings Required on the Job
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Organize and secure P&ID drawing;
b. Organize and secure calibration vendor information;
c. Organize and secure calibration blank forms; and,
d. Organize and secure previous calibration sheets.

Module Outline:

I. P&ID Drawings
II. Calibration Sheets Format
III. Completed Calibration Sheets Format
IV. Calibration Vendor Information

INT-D1-LA
Organize Documents and Drawings Required on the Job
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-D1-LW

Organize Documents and Drawings Required on the Job

Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Organize and secure P&ID drawing;
   b. Organize and secure calibration vendor information;
   c. Organize and secure calibration blank forms; and,
   d. Organize and secure previous calibration sheets.

2. Student will practice:
   a. Organize and secure P&ID drawing;
   b. Organize and secure calibration vendor information;
   c. Organize and secure calibration blank forms; and,
   d. Organize and secure previous calibration sheets.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-D2

Subject: **Work Routines** **Time: 6 Hrs.**

Duty: **Organize Work Routines**
Task: Determine Proper Tools, Equipment, and Materials to Perform the Job

Objective(s):

Upon completion of this module the student will be able to:
a. Determine proper tools to perform the job;
b. Determine proper equipment to perform the job; and,.
c. Determine proper materials to perform the job.

Instructional Materials:

Digital VOM
Ice bath
Electrician hand tools
P&ID drawings
Pneumatic calibrator
MASTER Handout (INT-D2-HO)
MASTER Laboratory Aid (INT-D2-LA)
MASTER Laboratory Worksheet (INT-D2-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-D1 "Organize Documents and Drawings Required on the Job"

Introduction:

By determining the proper tools, equipment and materials to perform the job at the beginning of the project a great deal of time is not wasted.

Presentation Outline:

I. Electrical Hand Tools
II. P&ID Drawings
III. VOM
IV. Process Variables
V. Instruments for Measuring Process Variable

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-D3) dealing with coordinating work activities with other crafts or units.

INT-D2-HO
Determine Proper Tools, Equipment, and Materials to Perform the Job
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Determine proper tools to perform the job;
b. Determine proper equipment to perform the job; and,.
c. Determine proper materials to perform the job.

Module Outline:

I. Electrical Hand Tools
II. P&ID Drawings
III. VOM
IV. Process Variables
V. Instruments for Measuring Process Variable

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-D2-LW
Determine Proper Tools, Equipment, and Materials to Perform the Job
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Determine proper tools to perform the job;
   b. Determine proper equipment to perform the job; and,
   c. Determine proper materials to perform the job.

2. Student will practice:
   a. Determine proper tools to perform the job;
   b. Determine proper equipment to perform the job; and,
   c. Determine proper materials to perform the job.

3. Instructor will grade student's performance on:
   a. Determine proper tools to perform the job;
   b. Determine proper equipment to perform the job; and,
   c. Determine proper materials to perform the job.

Name:_____ Date:_____

INT-D2
Determine Proper Tools, Equipment, and Materials to Perform the Job
Self-Assessment

1. The purpose of a pneumatic transmitter in a level-measuring system is to _____.
   a. Control the flow in and out of the tank
   b. Show the pressure difference between two taps
   c. Regulate diaphragm movement
   d. Link the measuring element and the display

2. Which of the following devices can be used to indicate flow and level as well as pressure?
   a. Bourdon tube
   b. Radiation pyrometer
   c. Strain gauge
   d. Thermocouple

3. The change in resistance of a strain gauge is caused by a change in its _____.
   a. Dimension
   b. Ductility
   c. Elastic limit
   d. Proportional limit

4. An ultrasonic level detector uses _____ as a measure of the height of a liquid's surface.
   a. Current
   b. Elapsed time
   c. Frequency
   d. Loudness

5. Pyrometers use _____ to determine temperatures.
   a. Conduction
   b. Convection
   c. Radiation
   d. Resonance

6. A disadvantage of solenoid valves is that they _____.
   a. Are complex and expensive
   b. Provide only on-off control
   c. Require servo valves for rotary control
   d. Respond slowly

7. The part of a DC motor that often needs cleaning or replacement is the _____.
   a. Dynamometer
   b. Megohm meter
   c. Oscilloscope
   d. Test stand

8. In a cascade control system, the final control element is controlled by _____.
   a. Either the primary or secondary controller
   b. The master controller
   c. The output of a summing device
   d. The slave controller

9. Which of the following data transmission methods is useful over the greatest distance?
   a. Electronic
   b. Fiber optic
   c. Pneumatic
   d. Wide band

INT-D2
Determine Proper Tools, Equipment, and Materials to Perform the Job
Self-Assessment Answer Key

1. d
2. a
3. a
4. c
5. c
6. c
7. b
8. b
9. d

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-D3

Subject: **Instrumentation** **Time: 4 Hrs.**

Duty: **Organize Work Routines**
Task: Coordinate Work Activities With Other Crafts or Units

Objective(s):

Upon completion of this module the student will be able to:

a. Coordinate work activities with console operators;
b. Coordinate work activities with field operators; and,
c. Coordinate work activities with maintenance workers.

Instructional Materials:

Telephone
Walkie Talkie or Equivalent
MASTER Handout (INT-D3-HO)
MASTER Laboratory Aid (INT-D3-LA)
MASTER Laboratory Worksheet (INT-D3-LW)

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

INT-D2 "Determine Proper Tools, Equipment, and Materials to Perform the Job"

Introduction:

Timing allows production to flow smoother.

Presentation Outline:

I. Console Operator Duties
II. Field Operator Duties
III. Maintenance Worker Duties

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-D4) dealing with coordinating preventive maintenance schedule with planning group.

INT-D3-HO
Coordinate Work Activities with Other Crafts or Units
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Coordinate work activities with console operators;
b. Coordinate work activities with field operators; and,
c. Coordinate work activities with maintenance workers.

Module Outline:

I. Console Operator Duties
II. Field Operator Duties
III. Maintenance Worker Duties

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-D3-LW
Coordinate Work Activities with Other Crafts or Units
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Coordinate work activities with console operators;
   b. Coordinate work activities with field operators; and,
   c. Coordinate work activities with maintenance workers.

2. Student will demonstrate how to:
   a. Coordinate work activities with console operators;
   b. Coordinate work activities with field operators; and,
   c. Coordinate work activities with maintenance workers.

3. Instructor will grade student's ability to:
   a. Coordinate work activities with console operators;
   b. Coordinate work activities with field operators; and,
   c. Coordinate work activities with maintenance workers.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-D4

Subject: Instrumentation **Time: 5 Hrs.**

Duty: Organize Work Routines
Task: Coordinate Preventive Maintenance Schedule with Planning Group

Objective(s):

Upon completion of this module the student will be able to:

a. Define preventive maintenance;
b. Define planning group;
c. List communication techniques; and,
d. List common communication procedures.

Instructional Materials:

MASTER Handout (INT-D4-HO)
MASTER Laboratory Aid (INT-D4-LA)
MASTER Laboratory Worksheet (INT-D4-LW)

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-D3 "Coordinate Work Activities with Other Crafts or Units"

Introduction:

Preventive maintenance usually allows more effective operation and less equipment breakdowns.

Presentation Outline:

I. Define Preventive Maintenance
II. Define Planning Group
III. List Communication Techniques
IV. List Common Communication Procedures

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-D5) dealing with verifying equipment isolation prior to performance of work for safety reasons.

INT-D4-HO
Coordinate Preventive Maintenance Schedule with Planning Group
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define preventive maintenance;
b. Define planning group;
c. List communication techniques; and,
d. List common communication procedures.

Module Outline:

I. Define Preventive Maintenance
II. Define Planning Group
III. List Communication Techniques
IV. List Common Communication Procedures

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-D4-LW
Coordinate Preventive Maintenance Schedule with Planning Group
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will:
   a. Identify safety equipment appropriate to protect the eyes from flying particle matter or chemicals;
   b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
   c. Identify equipment appropriate to protect against high level of noise;
   d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,
   e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

2. Student will:
   a. Identify safety equipment appropriate to protect the eyes from flying particle matter or chemicals;
   b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
   c. Identify equipment appropriate to protect against high level of noise;
   d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,
   e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

3. Instructor will grade student's performance in:
   a. Identify safety equipment appropriate to protect the eyes from flying particle matter or chemicals;
   b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
   c. Identify equipment appropriate to protect against high level of noise;
   d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,
   e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-D5

Subject: **Instrumentation** **Time: 3 Hrs.**

Duty: **Organize Work Routines**
Task: Verify Equipment Isolation Prior to Performance of Work for Safety Reasons

Objective(s):

Upon completion of this module the student will be able to:

a. Read P&ID diagrams;
b. List specific steps in order to isolate equipment; and,
c. Demonstrate knowledge of safety rules and regulations in handling corrosive materials.

Instructional Materials:

P&ID drawings for a specific process area
MASTER Handout (INT-D5-HO)
MASTER Laboratory Aid (INT-D5-LA)
MASTER Laboratory Worksheet (INT-D5-LW)

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

INT-D4 "Coordinate Preventive Maintenance Schedule with Planning Group"

Introduction:

Equipment isolation for calibration, testing, maintenance and troubleshooting allows one to safely continue with a functional process. Isolation may mandate implementing a bypass procedure must be followed rigorously in order to deal with equipment safely.

Presentation Outline:

I. Instrumentation Symbols
II. P&ID Diagrams
III. Isolation Procedures
IV. Procedures to Go from Isolation Back to Normal Operation
V. Documentation to Support Isolation Procedures

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-D6) dealing with reporting abnormal equipment problems to supervisor.

INT-D5-HO
Verify Equipment Isolation
Prior to Performance of Work for Safety Reasons
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Read P&ID diagrams;
b. List specific steps in order to isolate equipment; and,
c. Demonstrate knowledge of safety rules and regulations in handling corrosive materials.

Module Outline:

I. Instrumentation Symbols
II. P&ID Diagrams
III. Isolation Procedures
IV. Procedures to Go from Isolation Back to Normal Operation
V. Documentation to Support Isolation Procedures

INT-D5-LA
Verify Equipment Isolation
Prior to Performance of Work for Safety Reasons
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-D5-LW
Verify Equipment Isolation
Prior to Performance of Work for Safety Reasons
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate:
   a. Isolation procedure; and,
   b. Change back from isolation to normal operation.

2. Student will practice:
   a. Isolation procedure; and,
   b. Change back from isolation to normal operation.

3. Instructor will grade student on performance of:
   a. Isolation procedure; and,
   b. Change back from isolation to normal operation.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-D6

Subject: **Instrumentation** **Time: 2 Hrs.**

Duty: **Organize Work Routines**
Task: Report Abnormal Equipment Problems to Supervisor

Objective(s):

Upon completion of this module the student will be able to:

a. Report abnormal equipment problems to supervisor (team leader); and,
b. Recognize abnormal equipment problems.

Instructional Materials:

Classroom
Chalkboard
MASTER Handout (INT-D6-HO)
MASTER Self-Assessment

References:

Supervision, Zenger Miller Publishers, Latest Edition
Pathway To Technology, CORD Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

INT-D5 "Verify Equipment Isolation Prior to Performance of Work for Safety Reasons"

Introduction:

Following normal management and company policy is important to maintain minimum communications standards.

Presentation Outline:

I. Recognize Abnormal Equipment Problems
II. Five Senses
    A. Hear-unusual sounds

B. See-discolor, burn
C. Touch-unusual hot or cold
D. Feel-unusual shape or size
E. Smell-burn, unusual small

III. Use Five Senses to Recognize Abnormal Equipment Problem
IV. Report Abnormal Equipment Problems to Supervisor

Practical Application:

Student will use five senses to detect unusual equipment problems.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-D7) dealing with writing new calibration procedures if needed.

INT-D6-HO
Report Abnormal Equipment Problems to Supervisor
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Report abnormal equipment problems to supervisor (team leader); and,
b. Recognize abnormal equipment problems.

Module Outline:

I. Recognize Abnormal Equipment Problems
II. Five Senses
  A. Hear-unusual sounds
  B. See-discolor, burn
  C. Touch-unusual hot or cold
  D. Feel-unusual shape or size
  E. Smell-burn, unusual small
III. Use Five Senses to Recognize Abnormal Equipment Problem
IV. Report Abnormal Equipment Problems to Supervisor

Name:_____ Date:_____

INT-D6
Report Abnormal Equipment Problems to Supervisor
Self-Assessment

Assessment: Attention to Detail

The number/letter strings are supposed to be the same. Identify the letter of the item which is different.

1.	11797	11797	11977	11797	11797
	A.	B.	C.	D.	E.
2.	22323	22323	22323	23323	22323
	A.	B.	C.	D.	E.
3.	14A27	14A27	14A27	14A27	1A427
	A.	B.	C.	D.	E.
4.	3X254	3Y254	3X254	3X254	3X254
	A.	B.	C.	D.	E.
5.	1AX4DU	1AX4DU	1AX4DU	1AX4DU	1XA4DU
	A.	B.	C.	D.	E.

Assessment: Five Senses

1. Select the statement which lists the largest items:
   a. Car, mouse, house
   b. Toy car, moose, doll house
   c. Car, moose, house
   d. Car, moose, doll house

2. Select the statement which lists items that are alive:
   a. Cow, goal, whale
   b. Cow, gull, whale
   c. Caw, gull, whole
   d. Caw, goal, whale

3. Select the statement which lists items that are round:
   a. Cookie, balloon, sun
   b. Cracker, kite, moon
   c. Golf ball, golf club, golf tee
   d. Coffee mug, wheel, moon

4. Select the statement which lists items that smell good:
   a. Chocolate cake, car exhaust, soap
   b. Perfume, apple pie, mints
   c. Old sneakers, fabric softener, wood smoke
   d. Baking bread, swamp, flowers

5. Select the statement which lists items that smell bad:
   a. Laundry, roast turkey, inside of a new car
   b. Soft drink, milk left in the sun
   c. Cookies, cold glass of milk
   d. Landfill, old fish, auto exhaust

6. Select the statement which lists items you'd most expect to smell in a factory:
   a. Burning leaves, fresh coffee
   b. Tar, air freshener, exhaust fumes
   c. Paint, gasoline, ammonia
   d. Baby powder, barbecue, wood smoke

7. Select the statement which lists items you'd expect to feel soft or smooth edges:
   a. Kitchen table, crock pot, eyeglasses
   b. Hats, gloves, shoes
   c. Books, newspapers, pictures
   d. Baby's skin, pillow, marshmallows

8. Select the statement which lists items you'd expect to have rougher sharp edges:
   a. Pineapple, corn, sandpaper
   b. Apple, sofa, crib
   c. Brick, tile, wallpaper
   d. Skyscraper, dome, trailers

9. Select the statement that lists items you'd expect to hear in the country:
   a. Chain saw, steamboat, whistle
   b. Streetcars, buses, taxis
   c. Seagull, heron, owls
   d. Chickens, pigs, cows

10. Select the statement that lists items you'd expect to hear in a big city:
   a. Chain saw, steamboat, whistle
   b. Streetcars, buses, taxis
   c. Seagull, heron, owls
   d. Chickens, pigs, cows

11. Select the statement that list items you'd expect to taste sweet:
   a. Bread, roast beef, salad
   b. Apple pie, dill pickle, squash pie
   c. Candy, cookies, cakes
   d. Carrot cake, cole slaw, cabbage

12. Select the statement that lists items you'd expect to taste crunchy:
   a. Carrots, apples, celery
   b. Lettuce spinach, muffins
   c. Mashed potatoes, french fries, baked potatoes
   d. Cereal, crackers, oatmeal

13. Select the items you'd expect to taste salty:
   a. Barbecue, applesauce, cornbread
   b. Chocolate, coffee, tea
   c. Popcorn, caramel corn, caramels
   d. Pretzels, potato chips, popcorn

INT-D6
Report Abnormal Equipment Problems to Supervisor
Self-Assessment Answer Key

Attention to Detail

1. C
2. D
3. E
4. B
5. E

Five Senses

1. C
2. B
3. A
4. B
5. D
6. C
7. D
8. A
9. D
10. B
11. C
12. A
13. D

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-D7

Subject: **Instrumentation** **Time: 5 Hrs.**

Duty: **Organize Work Routines**
Task: Write New Calibration Procedures If Needed

Objective(s):

Upon completion of this module the student will be able to write new calibration procedures.

Instructional Materials:

Sample calibration procedure
MASTER Handout (INT-D7-HO)
MASTER Laboratory Aid (INT-D7-LA)
MASTER Laboratory Worksheet (INT-D7-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-D6 "Report Abnormal Equipment Problems to Supervisor"

Introduction:

Calibration is important to maintain the integrity of the equipment. Most processes are systematic about frequency and method of performance. Calibration must be traceable back to NIST standards.

Presentation Outline:

I. Define Calibration Procedures
II. Sections of Calibration Procedures
III. Using Calibration Procedure
IV. Getting Acquainted with Calibration Device
V. Equipment Necessary to Perform Calibration
VI. Calibration Steps
VII. Interpretation of Calibration Results
VIII. Forms to Record Calibration Values
IX. NIST Calibration Standards
X. Standards
XI. Interview SME (IE Tech)

Practical Application:

Student will write a sample calibration procedure.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-D8) dealing with following specifications and procedures.

INT-D7-HO
Write New Calibration Procedures If Needed
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to write new calibration procedures.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publication, Latest Edition:

Chapter	Title
10	Measurement

Module Outline:

I. Define Calibration Procedures
II. Sections of Calibration Procedures
III. Using Calibration Procedure
IV. Getting Acquainted with Calibration Device
V. Equipment Necessary to Perform Calibration
VI. Calibration Steps
VII. Interpretation of Calibration Results
VIII. Forms to Record Calibration Values
IX. NIST Calibration Standards
X. Standards
XI. Interview SME (IE Tech)

INT-D7-LA
Write New Calibration Procedures If Needed
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Write a sample calibration procedure.

INT-D7-LW
Write New Calibration Procedures If Needed
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to write sample calibration procedure.

2. Student will write a calibration procedure.

3. Student will be graded on ability to write sample calibration procedure.

Name:_____ Date:_____

INT-D7
Write New Calibration Procedures If Needed
Self-Assessment

1. Define calibration.

2. List sections of a calibration procedure.

3. List action to take while using a calibration procedure.

4. List ways to get acquainted with a calibration device.

5. List equipment necessary to perform calibration.

6. List calibration steps.

7. List forms used to record calibration values.

8. What are NIST calibration standards?

INT-D7
Write New Calibration Procedures If Needed
Self-Assessment Answer Key

1. Comparing measured values of a quality being measured to the output of the device that measures it.

2. Company on measured device, data on standard, data on measured device, date, people involved, actions taken.

3. Adjust measured device to standard.

4. Read vendors literature on calibrate device, training.

5. Standards calibrated to NIST or verification lab.

6. Usually look at 0%, 50% and 100%.

7. Company calibration forms.

8. National institute of standards and technology.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-D8

Subject: Instrumentation **Time: 3 Hrs.**

Duty: Organize Work Routines
Task: Follow Specifications and Procedures

Objective(s):

Upon completion of this module the student will be able to follow specifications and procedures.

Instructional Materials:

Sample specification sheet
MASTER Handout (INT-D8-HO)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-D7 "Write New Calibration Procedures If Needed"

Introduction:

Specifications are used to list technical limits of a device or product. When manufacturing, specifications outline maximum and minimum acceptable values. Good customer relations demand adherence to these specifications.

Presentation Outline:

I. Define Specifications
II. Major Areas of Specification
III. Who Writes Specifications
IV. How to Apply Specification
V. SPC
VI. Quality
VII. Control Charts

Practical Application:

Student will write a sample specification.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-D9) dealing with performing algebraic operations.

INT-D8-HO
Follow Specification and Procedures
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to follow specifications and procedures.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
1	Characteristics of Instruments

Module Outline:

I. Define Specifications
II. Major Areas of Specification
III. Who Writes Specifications
IV. How to Apply Specification
V. SPC
VI. Quality
VII. Control Charts

Name:_____ Date:_____

INT-D8
Follow Specification and Procedures
Self-Assessment

1. Define specifications.

_____
_____
_____

2. What are the major areas of a specification?

_____
_____
_____

3. Who writes specifications?

_____
_____
_____

4. What is SPC?

_____
_____
_____

5. Define quality?

_____
_____
_____

6. What are control charts?

_____
_____
_____

INT-D8
Follow Specification and Procedures
Self-Assessment Answer Key

1. A list of requirements to be met when manufacturing a product.

2. Dimension, tolerances, materials, views of product.

3. Plant engineering.

4. Statistical Process Control.

5. Conformance to requirements.

6. Line charts used to graphically display data. Commonly used as a SPC tool.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-D9

Subject: Instrumentation **Time: 6 Hrs.**

Duty: Organize Work Routines
Task: Perform Basic Algebraic Operations

Objective(s):

Upon completion of this module the student will be able to:

a. Define formula;
b. Define equation;
c. Define term;
d. Demonstrate that you understand what combinations of letters and numbers or letters indicate in formulas;
e. Demonstrate that you understand what parentheses or brackets indicate in formulas;
f. Change certain sentences about mathematical relationships into formulas; and,
g. Demonstrate that you can rearrange formulas in order to find various unknowns.

Instructional Materials:

Paper
Pencil
Chalkboard
Overhead Projector
MASTER Handout (INT-D9-HO)
MASTER Laboratory Worksheet (INT-D9-LW)
MASTER Self-Assessment

References:

Applied Electronic Math, with Calculators, John W. Tontsch, Latest Edition
Applied Math, Avi C. Bajpai, Rodney M. Bond; adapted by Jerry W. Jones, Latest Edition
Applied Math for Technicians, Claude S. Moore, Bennie L. Griffin, Edward C. Polhamus, Jr.; {drawings, George E. Morris.}, Latest Edition
Basic Business Math, Robert L. Dansby, Latest Edition

Basic Electronics Math with a Scientific Calculator, by Edward M. Noll, Latest Edition
Becoming a Mental Math Wizard, Jerry Lucas, Latest Edition
Building Success in Math, Carol R. Langbort, Virginia H. Thompson, Latest Edition
Business Math Basics, Robert E. Swindle, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-D8 "Follow Specifications and Procedures"

Introduction:

This module includes basic techniques used in working with formulas. In this module, you will consider approaches to working formulas. These are methods you can apply whenever you have to use formulas. In this module, you will learn how to substitute values in formulas. You will learn how to use formulas to find various unknowns. You will practice what you learn by working some practical formulas.

Presentation Outline:

I. Formula Components
   Terms, brackets, parentheses, letters, number
II. What a Formula Does
   State relationships
III. Principles for Solving Formulas
IV. Ratio for Solving Formulas
V. Practice Using Formulas

Practical Application:

Students will practice in the lab. Each student will complete the **MASTER** Laboratory Worksheet (INT-D9-LW) and turn it in to the instructor for checking.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objective as a guide for discussion and work problems on **MASTER** laboratory worksheet.

Next Lesson Assignment:

MASTER Technical Module (INT-D10) dealing with performing basic trigonometric functions.

INT-D9-HO
Perform Basic Algebraic Operations
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate ability to use formulas to solve mathematical problems.

Objectives:

Upon completion of this module the student will be able to:

a. Define formula;
b. Define equation;
c. Define term;
d. Demonstrate that you understand what combinations of letters and numbers or letters indicate in formulas;
e. Demonstrate that you understand what parentheses or brackets indicate in formulas;
f. Change certain sentences about mathematical relationships into formulas; and,
g. Demonstrate that you can rearrange formulas in order to find various unknowns.

Rules for Dealing with Formulas:

1. A formula is a way of briefly expressing a rule, fact, or principle by the use of symbols or letters.

2. Formulas are equations. An equation is a statement that the quantities on each side of the equal sign equal the same thing.

3. Combinations of letters and/or numbers indicate multiplication.

4. Parentheses ( ) or brackets [ ] are grouping symbols. They indicate that the quantities within them are to be grouped together, and are to be considered as one quantity. When working with formulas that have parentheses, first do the operation indicated within the parentheses. When both brackets and parentheses are present work within the brackets.

5. Formulas state relationships that have been tested and proven to be true. A formula is a sentence where letters, symbols, and numbers substitute for words.

6. Sometimes, you know the value of the quantity to the left of the equal sign, but not all the values to the right. You can still work the formula by reattaching it.

7. There are some rules of procedure you must follow when you rearrange equations. One important principle is cancellation. Cancellation removes a common element from a fractions numerator and denominator on one side of an equation.

8. Another important principle states that what is done to one side an equation, must be done to the other side. Another principle used in solving formula is transposition. This states that when you move quantity form one side of an equation to the other, you change its sign or operation.

Reading Assignments:

The following chapters are assigned to read from ***Math for Consumers***, D.S. Kaine and L.S. Kaine, Advisor-Wesley Pub. Co., Latest Edition:

Chapter	**Title**
	Equation Solving

Module Outline:

I. Formula Components
   Terms, brackets, parentheses, letters, number
II. What a Formula Does
   State Relationships
III. Principles for Solving Formulas
IV. Ratio for Solving Formulas
V. Practice Using Formulas

Glossary:

Cancellation
Removing a common element from a numerator and a denominator of a fraction on one side of an equation.

Equation
A statement that two quantities are equal.

Formula
A way of briefly expressing a rule, fact, or principle by the use of symbols or letters. A formula is an equation.

Term

Numbers or symbols combined by multiplication, division, addition, or subtraction.

Transportation

The process of moving a quantity from one side of an equation to the other by changing its sign of operation.

INT-D9-LW
Perform Basic Algebraic Operations
Attachment 2: **MASTER** Laboratory Worksheet

Worksheet:

1. Formulas:
   a. are equations.
   b. show how some quantities are related to each other.
   c. state relationships which have been tested and proven to be true.
   d. all of the above.

2. In a formula terms are:
   a. numbers or symbols combined by addition or subtraction.
   b. numbers or symbols combined by addition, subtraction, multiplication, or division.
   c. numbers or symbols.
   d. none of the above.

3. Parentheses or brackets in a formula mean:
   a. quantities within them are to be grouped together.
   b. quantities within them are to be considered one quantity.
   c. first do the work indicated within the parentheses.
   d. all of the above.

4. Write the formula for the following sentence. Profit (P) equals the margin (M) minus the overhead (O).

   _____

5. Write the formula for the following sentence. The amperage (A) of an electrical circuit is equal to the wattage (W) divided by the voltage (V).

   _____

6. Write the sentence for the following formula. I=PRT (I is interest on money, P is principal, R is rate, and T is time).

   _____

7. Write the sentence for the following formula. HP=VA/746 horsepower on an electric motor, V is volts, and a amperes.

   _____

Name:_____ Date:_____

INT-D9
Perform Basic Algebraic Operations
Self-Assessment

1. Rearrange the formula $F_1 \times D_1 = F_0 \times D_0$ to solve for D_1. (Show all steps.)

_____

_____

2. Rearrange the formula $A = L \times W$ to solve for W. (Show all steps.)

_____

_____

3. Write the sentence that is the equivalent of the formula $A = L \times W$. (A = area of a rectangle, L = Length, and W = width.)

_____

_____

4. Assume that W represents work, F represents force, and D represents distance. Write a formula that shows distance multiplied by force equals work.

_____

_____

5. In a formula, a combination of a number and a letter or two letters, like 3A or BC indicates:
   a. addition
   b. multiplication
   c. either of the above, depending on the sign in the equation.
   d. none of the above

6. Equations are:
   a. formulas
   b. statements of principles
   c. statements that two quantities are equal
   d. all of the above

7. Formulas:
   a. are equations
   b. show how some quantities are related to each other
   c. state relationships which have been tested and proven to be true
   d. all of the above

INT-D9
Perform Basic Algebraic Operations
Self-Assessment Answer Key

1. $F_1 \times D_1 = F_0 \times D_0$; therefore, $D_1 = (F_0 \times D_0) / F_1$

2. A=LxW; therefore, A/L = W

3. Area of a rectangle = Length times width

4. Distance multiplied by force = Work; therefore DxF = W

5. b

6. d

7. d

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-D10

Subject: **Instrumentation** **Time: 50 Hrs.**

Duty: **Organize Work Routines**
Task: Perform Basic Trigonometric Functions

Objective(s):

Upon completion of this module the student will be able to:

a. Solve trigonometric functions use a sin equation;
b. Solve trigonometric functions use a cos equation;
c. Solve trigonometric functions use a csc equation;
d. Solve trigonometric functions use a tan equation;
e. Solve trigonometric functions use a cot equation;
f. Solve trigonometric functions use a sec equation;
g. Solve for unknown sides, angles or radians for a right triangle;
h. Convert radians to degrees; and,
i. Convert degrees to radians.

Instructional Materials:

MASTER Handout (INT-D10-HO)
MASTER Laboratory Worksheet (INT-D10-LW)
MASTER Self-Assessment
Paper
Pencil
Chalk Board
Overhead Projector

References:

Applied Electronic Math, with calculators, John W. Tontsch, Latest Edition
Applied Math, Avi C. Bajpai, Rodney M. Bond; adapted by Jerry W. Jones, Latest Edition
Applied Math for Technicians, Claude S. Moore, Bennie L. Griffin, Edward C. Polhamus, Jr.; {drawings, George E. Morris.}, Latest Edition
Basic Business Math, Robert L. Dansby, Latest Edition
Basic Electronics Math with a Scientific Calculator, by Edward M. Noll, Latest Edition

Becoming a Mental Math Wizard, Jerry Lucas, Latest Edition
Building Success in Math, Carol R. Langbort, Virginia H. Thompson, Latest Edition
Business Math Basics, Robert E. Swindle, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-D9 "Perform Basic Algebraic Operations"

Introduction:

Trigonometry in a study of right triangles. The right triangle is useful in studying angles, arcs, and distances.

Presentation Outline:

I. Solve Trigonometric Functions Use a Sin Equation
II. Solve Trigonometric Functions Use a Cos Equation
III. Solve Trigonometric Functions Use a Csc Equation
IV. Solve Trigonometric Functions Use a Tan Equation
V. Solve Trigonometric Functions Use a Cot Equation
VI. Solve Trigonometric Functions Use a Sec Equation
VII. Solve For Unknown Sides, Angles or Radians For a Right Triangle
VIII. Convert Radians to Degrees
IX. Convert Degrees to Radians

Practical Application:

Students will practice working math problems. Each student will complete the **MASTER** Laboratory Worksheet (INT-D10-LW) and turn it in to the instructor for checking.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of written evaluation.

Summary:

Review the main lesson points using the **MASTER** Handout (INT-D10-HO) as a guide for discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-D11) dealing with performing basic calculus operations.

INT-D10-HO
Perform Basic Trigonometric Functions
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the classroom by not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Solve trigonometric functions use a sin equation.;
b. Solve trigonometric functions use a cos equation;
c. Solve trigonometric functions use a csc equation;
d. Solve trigonometric functions use a tan equation;
e. Solve trigonometric functions use a cot equation;
f. Solve trigonometric functions use a sec equation;
g. Solve for unknown sides, angles or radians for a right triangle;
h. Convert radians to degrees; and,
i. Convert degrees to radians.

Reading Assignments:

The following chapters are assigned to read from ***Mathematics for Technicians*** by Edward Tronaas, Prentice Hall Publishers, Latest Edition:

Chapter	Title
9	Trigonometry

Module Outline:

I. Solve Trigonometric Functions Use a Sin Equation
II. Solve Trigonometric Functions Use a Cos Equation
III. Solve Trigonometric Functions Use a Csc Equation
IV. Solve Trigonometric Functions Use a Tan Equation
V. Solve Trigonometric Functions Use a Cot Equation
VI. Solve Trigonometric Functions Use a Sec Equation
VII. Solve For Unknown Sides, Angles or Radians For a Right Triangle
VIII. Convert Radians to Degrees
IX. Convert Degrees to Radians

INT-D10-LW
Perform Basic Trigonometric Functions
Attachment 2: **MASTER** Laboratory Worksheet

Worksheet:

(Use Trig Function Tables)

Solve:

1. Sin 22° 18' = _____
2. Cot 22° 18' = _____
3. Sec 22° 18' = _____
4. Tan 22° 18' = _____
5. Csc 22° 18' = _____
6. Cos 22° 18' = _____
7. Cos A = 0.69675 _____
8. Cot A = 1.1340 _____
9. Sin A = 0.98531 _____
10. Sec A = 1.5753 _____
11. Tan A = 0.50587 _____
12. 2∏ Radians = _____ Degrees
13. 180 Degrees = _____ Radians
14. ∏ Radians = _____ Degrees

Name:_____ Date:_____

INT-D10
Perform Basic Trigonometric Functions
Self-Assessment

(Use Trig Function Tables)

Solve:

1. 97 Degrees = _____ Radians
2. 1.5 [] Radians = _____ Degrees
3. Sin 37° 14' = _____
4. Cos 156° 16' = _____
5. Tan 41° 11' = _____
6. Sec 18° 9' = _____
7. Csc 8° 8' = _____
8. Cot 21° 8' = _____
9. Sec A = 1.5753 _____
10. Sin A = 0.98531 _____

INT-D10
Perform Basic Trigonometric Functions
Self-Assessment Answer Key

1. 1.69
2. 270
3. 0.6050
4. .55533
5. 0.87492
6. 0.0524
7. 3.2131
8. 0.5871
9. 50° 36°
10. 79° 50°

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-D11

Subject: **Instrumentation** **Time: 60 Hrs.**

Duty: **Organize Work Routines**
Task: Perform Basic Calculus Operations

Objective(s):

Upon completion of this module the student will be able to solve for:

a. Limits;
b. Derivatives;
c. Graphs;
d. Unknowns using differentiation;
e. Differentials using trigonometric functions;
f. Differentials using logarithms;
g. Higher order derivatives;
h. Differentials using exponentials;
i. Area under a curve;
j. Unknowns using integration;
k. Definite integrals; and,
l. Numerical integration.

Instructional Materials:

Chalkboard or White Board or Flip Chart
MASTER Handout (INT-D11-HO)
MASTER Laboratory Worksheet (INT-D11-LW)
MASTER Self-Assessment

References:

Basic Technical Math with Calculus, Washington, Benjamin Cummings Publishing, Latest Edition
Technical Math with Calculus, Rice, McGraw Hill Publishing, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-D10 "Perform Basic Trigonometric Functions"

Introduction:

Calculus is a mathematical tool for solving problems involving figures that are not common. Calculus won't be mastered overnight. It will require work in order to gain a basic knowledge of the subject. Calculus involves using graphs, trigonometric function, exponentials, and logarithms.

Presentation Outline:

I. Limits
II. Derivatives
III. Graphs of Functions
IV. Differentiation
V. Differentiating Trigonometric Functions
VI. Differentiation of Logarithms and Exponentials
VII. Higher Order Derivatives
VIII. Differentials
IX. Area under a Curve
X. Integration
XI. Techniques of Integration
XII. Definite Integrals and Numerical Integration

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-E1) dealing with recording test/calibration data.

INT-D11-HO
Perform Basic Calculus Operations
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to solve for:

a. Limits;
b. Derivatives;
c. Graphs;
d. Unknowns using differentiation;
e. Differentials using trigonometric functions;
f. Differentials using logarithms;
g. Higher order derivatives;
h. Differentials using exponentials;
i. Area under a curve;
j. Unknowns using integration;
k. Definite integrals; and,
l. Numerical integration.

Reading Assignments:

Quick Calculus, Kleppner and Ramsey, John Wiley Company Publishing, Latest Edition:

Chapter	Title
2	Differential Calculus
3	Integral Calculus

Module Outline:

I. Limits
II. Derivatives
III. Graphs of Functions
IV. Differentiation
V. Differentiating Trigonometric Functions
VI. Differentiation of Logarithms and Exponentials
VII. Higher Order Derivatives
VIII. Differentials
IX. Area under a Curve
X. Integration
XI. Techniques of Integration
XII. Definite Integrals and Numerical Integration

INT-D11-LW
Perform Basic Calculus Operations
Attachment 2: **MASTER** Laboratory Worksheet

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1. A set is a **collection of objects**.

2. A function is a **rule that assigns to each element in a set**.

3. Angles are measured in either **degrees or radians**.

4. 1 rad = **360°** divided by **2** π.

5. What is the definition of a limit? **Let *f(x)* be defined for all x in an interval about *x=a*, but not necessarily at *x=a*. If there is an number L such tat to each positive number ϵ there corresponds a positive number δ such that;**
   $|f(x) - L| < \epsilon$ **provided** $0 < |x - a| < \delta$.
   Therefore, L is the limit of *f(x)* as *x* approaches *a*.

6. If $y=f(x)$, then the rate of change of y with respect to x is;

   lim $(\Delta y/\Delta x)$**. The lim** $(\Delta y/\Delta x)$ **is called the derivative of *y* with respect to *x*,** $[(\Delta x \to 0), (\Delta y \to 0)]$ **and may be written written as** (dy/dx).

7. Plot $y = mx + b$.

8. Let u and v be variables that depend on x.

   $[d(uv)/dx] = u\,[dv/dx] + v\,[du/dx] + 0$

9. $\text{Sin}(\theta + \varnothing) = \sin\theta \cos\varnothing + \cos\theta \sin\varnothing$

10. a to the m power times a to the n power equals **a to the m + n power**.

11. Log x is; $x = 10$ **to the log *x* power**.

12. If $A(x)$ is the area under the curve defined by $y = f(x)$, then;

    $[dA(x)/dx] = A'(x) = f(x)$.

13. Using integration solve for $F(x)$; $F(x) = \int f(x)\,dx$.

13. Using integration solve for F(x); $\mathbf{F(x) = \int f(x)\,dx}$.

14. Suppose the A(x) under a curve is defined by the y = $f(x)$ is written as A(x) = F(x) + C, where F(x) is any antiderivative of f(x) and C is a constant. The area under the curve between $x = a$ and $x = b$ is then;
A(b) = F(b) - F(a)

Name:_____ Date:_____

INT-D11
Perform Basic Calculus Operations
Self-Assessment

1. Let u and v be variables that depend on x. Write a differential equation to show the relationship.

_____
_____
_____

2. If A(x) is the area under the curve defined by $y = f(x)$, then the differential equation would be:

_____
_____
_____

3. A set is a _____.

4. A function is a _____.

5. What is the definition of a limit?

_____
_____
_____

6. If $y=f(x)$, then the rate of change of y with respect to x is (equation):

_____
_____
_____

7. Using integration solve for F(x);

_____
_____
_____

8. Suppose the A(x) under a curve is defined by the $y = f(x)$ is written as A(x) = F(x) + C, where F(x) is any antiderivative of f(x) and C is a constant. The area under the curve between $x = a$ and $x = b$ is then (equation):

_____
_____
_____

9. Sin $(\theta + \varnothing)$ = _____.

10. a to the m power times a to the n power equals _____.

11. Log x is; x = _____.

12. Angles are measured in either _____.

INT-D11
Perform Basic Calculus Operations
Self-Assessment Answer Key

1. $[d(uv)/dx] = u\,[dv/dx] + v\,[du/dx] + 0$

2. $[dA(x)/dx] = A'(x) = f(x)$

3. Collection of objects.

4. Rule that assigns to each element in a set,

5. Let $f(x)$ be defined for all x in an interval about $x=a$, but not necessarily at $x=a$. If there is an number L such that to each positive number ϵ there corresponds a positive number δ such that;
$|f(x) - L| < \epsilon$ provided $0 < |x - a| < \delta$. Therefore, L is the limit of $f(x)$ as x approaches a.

6. *lim* $(\Delta y/\Delta x)$. The lim $(\Delta y/\Delta x)$ is called the derivative of y with respect to x, $[(\Delta x \to 0), (\Delta x \to 0)]$ and may be written as (dy/dx).

7. $F(x); = \int f(x)\,dx$

8. $A(b) = F(b) - F(a)$

9. $\sin\theta \cos\varnothing + \cos\theta \sin\varnothing$

10. a to the m + n power

11. 10 to the log x power

12. degrees or radians

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and repair transmitters	C-12 Test different field sensing elements, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Calibrate transmitters	C-15 Tune controllers: pneumatic and electronic	C-16 Trouble-shoot and repair plant computing systems relating to process controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and repair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and configure smart field devices, i.e., transmitters and valves	C-35 Operate control systems including single element, cascade, ratio, and feedforward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Determine proper tools, equipment, and materials to perform the job	D-3 Coordinate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment isolation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibration procedures	D-8 Follow specifications and procedures	D-9 Perform algebraic operations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibration data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise procedures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Application of ISA/IIC standards	F-5 Understand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Understand personal computers	F-10 Attend on-going safety training courses	F-11 Participate in plant related training	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-E1

Subject: **Instrumentation** **Time: 2 Hrs.**

Duty: **Collect And File Data**
Task: Record Test/calibration Data

Objective(s):

Upon completion of this module the student will be able to:
a. Record test data; and,
b. Record calibration data.

Instructional Materials:

Sample data sheets
Sample calibration data
MASTER Handout (INT-E1-HO)
MASTER Laboratory Aid (INT-E1-LA)
MASTER Laboratory Worksheet (INT-E1-LW)

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-D11 "Perform Basic Calculus Operations"

Introduction:

Calibration and test information is essential to an industrial plant. Accuracy of proper placement of data on these sheets is a must.

Presentation Outline:

I. Define Test
II. Define Calibration
III. Components of Test Sheet
IV. Components of Calibration Sheet

Practical Application:

Student will demonstrate how to:
1. Record test data in an organized, logical manner; and,
2. Record calibration data in an organized, logical manner.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-E2) dealing with recording preventive maintenance data.

INT-E1-HO
Record Test/Calibration Data
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Record test data; and,
b. Record calibration data.

Module Outline:

I. Define Test
II. Define Calibration
III. Components of Test Sheet
IV. Components of Calibration Sheet

INT-E1-LA
Record Test/Calibration Data
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Demonstrate how to record test data in an organized, logical manner; and,
   c. Demonstrate how to record calibration data in an organized, logical manner.

INT-E1-LW
Record Test/Calibration Data
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Construct test data sheet;
   b. Fill out test data sheet;
   c. Construct calibration sheet; and,
   d. Fill out calibration sheet.

2. Student will demonstrate how to:
   a. Construct test data sheet;
   b. Fill out test data sheet;
   c. Construct calibration sheet; and,
   d. Fill out calibration sheet.

3. Instructor will grade student's ability to:
   a. Construct test data sheet;
   b. Fill out test data sheet;
   c. Construct calibration sheet; and,
   d. Fill out calibration sheet.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-E2

Subject: Instrumentation **Time: 6 Hrs.**

Duty: Collect and File Data
Task: Record Preventive Maintenance Data

Objective(s):

Upon completion of this module the student will be able to:

a. Define preventive maintenance;
b. List common P.M. schedules; and,
c. List common P.M. data.

Instructional Materials:

MASTER Handout (INT-E2-HO)
MASTER Laboratory Aid (INT-E2-LA)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-E1 "Record Test/Calibration Data"

Introduction:

Keeping accurate P.M. helps reduce downtime! This also allows one to make predictions based on trends.

Presentation Outline:

I. Preventive Maintenance Definition
II. Preventive Maintenance Data

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-E3) dealing with recording equipment disconnect data.

INT-E2-HO
Record Preventive Maintenance Data
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define preventive maintenance;
b. List common P.M. schedules; and,
c. List common P.M. data.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Company, Latest Edition:

Chapter	**Title**
	Data Logging

Module Outline:

I. Preventive Maintenance Definition
II. Preventive Maintenance Data

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Name:_____ Date:_____

INT-E2
Record Preventive Maintenance Data
Self-Assessment

1. Define preventive maintenance.
2. Define event recorder
3. Compare strip chart to circular chart.
4. Define P.M. software.
5. Explain how P.M. software works.

INT-E2
Record Preventive Maintenance Data
Self-Assessment Answer Key

1. Maintenance specifically designed to prevent faults from occurring during normal operation.

2. This recorder provides a pulse for on, no pulse for off. Specifically, instrument detects and records occurrence of events.

3. Strip chart is rectangular is shape, similar to a scroll. A circular chart is round.

4. Software for a computer that plans schedules, maintenance activities at predetermined times.

5. Follow menu suggestions provided by software. Input equipment and parts data. Follow recommendations by software manufacturer.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-E3

Subject: **Instrumentation** **Time: 3 Hrs.**
Duty: **Collect And File Data**
Task: Record Equipment Disconnect Data

Objective(s):

Upon completion of this module the student will be able to record equipment disconnect data for:

a. Fuses;
b. Circuit breakers;
c. Disconnects; and,
d. Protective relays.

Instructional Materials:

Sample equipment disconnect data
MASTER Handout (INT-E3-HO)
MASTER Laboratory Aid (INT-E3-LA)
MASTER Laboratory Worksheet (INT-E3-LW)
MASTER Self-Assessment

Reference:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-E2 "Record Preventive Maintenance Data"

Introduction:

As much as possible, a basic understanding of protective devices is a must to provide safe continuous service.

Presentation Outline:

I. Define Disconnect
II. Fuses (define)
III. Fuse Classifications
    A. Dual element
    B. Single element
    C. Current limiting
    D. Voltage rating
    E. Current rating
    F. Interrupting rating
    G. Physical size
    H. Type
IV. Define Circuit Breaker
V. Circuit Breaker Classification
    A. O
    B. OA
    C. FA
    D. FOA
    E. OCB
    F. Gas
    G. Metal clad
    H. Ratchet
VI. Define Disconnect
VII. Disconnect Classification
    A. 1⌀
    B. 3⌀
VIII. Protective Relay (define)
IX. Types of Protective Relays
    A. Over current
    B. Impedance
    C. Pilot wire
    D. Zone

Practical Application:

Student will demonstrate how to record equipment disconnect data.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-E4) dealing with evaluating collected data.

INT-E3-HO
Record Equipment Disconnect Data
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to record equipment disconnect data for:

a. Fuses;
b. Circuit breakers;
c. Disconnects; and,
d. Protective relays.

Reading Assignments:

Electrical Systems, Kirk, Delmar Publishers, Latest Edition

Chapter	Title
6	Protective Services

Module Outline:

I. Define Disconnect
II. Fuses (define)
III. Fuse Classifications
  A. Dual element
  B. Single element
  C. Current limiting
  D. Voltage rating
  E. Current rating
  F. Interrupting rating
  G. Physical size

H. Type

IV. Define Circuit Breaker

V. Circuit Breaker Classification
   A. O
   B. OA
   C. FA
   D. FOA
   E. OCB
   F. Gas
   G. Metal clad
   H. Ratchet

VI. Define Disconnect

VII. Disconnect Classification
   A. 1⌀
   B. 3⌀

VIII. Protective Relay (define)

IX. Types of Protective Relays
   A. Over current
   B. Impedance
   C. Pilot wire
   D. Zone

INT-E3-LA
Record Equipment Disconnect Data
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Demonstrate how to record equipment disconnect data.

INT-E3-LW
Record Equipment Disconnect Data
*Attachment 3: **MASTER** Laboratory Worksheet*

---

1. Instructor will demonstrate how to record equipment disconnect data for:
   a. Fuses;
   b. Circuit breaker;
   c. Disconnects; and,
   d. Protective relays.

2. Student will demonstrate how to record equipment disconnect data and be graded on these areas:
   a. Fuses;
   b. Circuit breaker;
   c. Disconnects; and,
   d. Protective relays.

Name:_____ Date:_____

INT-E3
Record Equipment Disconnect Data
Self-Assessment

1. List four switch designs that suppress sparks.
   a. Air gap, vacuum, inert gas, oil filled
   b. Oil filled, inert gas, air gap, photoelectric
   c. Air gap, vacuum, proximity, oil filled
   d. Vacuum, inert gas, ultrasonic, oil filled

2. A substation is a structure that contains _____ transformers that reduce high-voltage power to voltage levels used by consumers.
   a. Step up
   b. Step down
   c. Isolation
   d. Current

3. The secondary busses are part of the _____ section of a substation.
   a. Low voltage
   b. High voltage
   c. Transformer
   d. Current

4. Power losses and voltage losses are unacceptable when power is transmitted at a _____ voltage level across long distances.
   a. Decreasing
   b. High
   c. Low
   d. Increasing

5. Power factor correction in industrial power distribution systems is accomplished by using _____ to offset the total inductive load produced by the plant's equipment.
   a. Inductors
   b. Resistors
   c. Transistors
   d. Capacitors

6. The reason for using an isolation transformer is to _____.
   a. Reduce current levels
   b. Electrically isolate two circuits
   c. Reduce voltage levels
   d. Reduce impedance levels

7. The purpose of a _____ is to serve as a connecting point between high-voltage lines and the substation or high voltage lines and underground lines.
   a. Differential relay
   b. Pothead
   c. Over current relay
   d. Feedforward control

8. The purpose of a _____ is to provide over current protection for a single or three phase system.
   a. Differential relay
   b. Pothead
   c. Over current relay
   d. Feedforward control

9. The purpose of a _____ is to provide protection when one side of a transformer draws a disproportionate amount of current when compared to amount of current draw on the other side.
   a. Differential relay
   b. Pothead
   c. Over current relay
   d. Feedforward control

10. Two of the dangers that _____ switchgear help to prevent are fire or explosion, damage to the switch.
   a. Motor controlled
   b. High voltage
   c. Low voltage
   d. Spark-suppressing

11. The three main sections of a substation are the _____ section, _____ section, and _____ section.
   a. High voltage, low voltage, transmission
   b. Low voltage, transmission, distribution
   c. High voltage, transformer, low voltage
   d. Transformer, transmission, distribution

12. Using too little torque on a _____ connector can cause loose wires, creating high resistance.
    a. Armored cable
    b. Small
    c. Intermediate metal conduit
    d. Mechanical

13. According to the NEC Section 110-14, the four suitable methods for splicing or joining conductors are to use a splicing device, to _____, to weld, or to solder the splices.
    a. Crimp
    b. Attach wire binding screws
    c. Cad weld
    d. Braze

14. When you are opening or closing switches in a substation, safety rules require that you _____.
    a. Stand as far away as possible, and in front of the switch
    b. Stand as close as possible, and in front of the switch
    c. Stand as far away as possible, and in front of the switch
    d. Stand as far away as possible, and to one side of the switch

15. The ground line of power distribution system is never switched or protected by an over current device because an open ground line can stop a _____ from serving its circuit protection function.
    a. GFCI
    b. Circuit breaker
    c. Oil filled switch
    d. Air gap switch

16. Two general reasons for _____ electrical systems or equipment are protection of equipment and personnel, and lower effects of EMI.
    a. Cooling
    b. Grounding
    c. Splicing
    d. Brazing

17. According to the NEC Section 110-14, after conductors have been joined in a splice, the splice must be _____.
    a. Cleaned
    b. Checked for deteriorating agents
    c. Checked for temperature limitations of connectors
    d. Covered with insulation

18. One specific application for step-down transformers in a industrial facility or plant is to produce the low-voltage required by _____.
    a. Motors
    b. Motor control centers
    c. Welders
    d. Thermostats

19. A tool that is used in making taps is the _____ tool.
    a. Crimping
    b. Crescent wrench
    c. Screwdriver
    d. Air wrench

20. According to the NEC Section 110-14, before a splice is soldered, it must be _____.
    a. Mechanically and electrically secure
    b. Mechanically and electrically secure without solder
    c. Electrically secure
    d. Mechanically secure

21. The two common types of three-phase voltage supply configurations are the _____-wire 480 _____ and the _____-wire 480/277 _____.
    a. Three, delta, four, delta
    b. Three, wye, four wye
    c. Three, wye, three, delta
    d. Three, delta, four, wye

INT-E3
Record Equipment Disconnect Data
Self-Assessment Answer Key

1. a
2. b
3. c
4. c
5. d
6. b
7. b
8. c
9. a
10. d
11. c
12. d
13. a
14. d
15. b
16. b
17. d
18. d
19. a
20. a
21. a

INSTRUMENTATION SERIES

MASTER Technical Module No INT-E4

Subject: Instrumentation **Time: 4 Hrs.**

Duty: Collect and File Data
Task: Evaluate Collected Data

Objective(s):

Upon completion of this module the student will be able to:
a. Collect data; and,
b. Evaluate data.

Instructional Materials:

Sample data
Calibration procedure
Instrument installation guide
Instrument maintenance guide
SPC control chart data
MASTER Handout (INT-E4-HO)
MASTER Laboratory Aid (INT-E4-LA)
MASTER Laboratory Worksheet (INT-E4-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-E3 "Record Equipment Disconnect Data"

Introduction:

Organize data is useful information. Data that has not been evaluated for usefulness is not very good.

Presentation Outline:

I. Define Data
II. Classify Calibration Procedure
III. Define Job Performance Measure (JPM)
IV. Classify Installation Guide
V. Classify Maintenance Guide

Practical Application:

Student will demonstrate how to evaluate collected data.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-E5) dealing with reviewing/revising procedures if needed.

INT-E4-HO
Evaluate Collected Data
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Collect data; and,
b. Evaluate data.

Reading Assignments:

Instrumentation, Fribance, McGraw-Hill Publishers, Latest Edition:

The entire book

Module Outline:

I. Define Data
II. Classify Calibration Procedure
III. Define Job Performance Measure (JPM)
IV. Classify Installation Guide
V. Classify Maintenance Guide

INT-E4-LA
Evaluate Collected Data
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Demonstrate how to evaluate collected data.

INT-E4-LW
Evaluate Collected Data
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Collect data; and,
   b. Evaluate data.

2. Student will demonstrate how to:
   a. Collect data; and,
   b. Evaluate data.

3. Instructor will grade student's ability to:
   a. Collect data; and,
   b. Evaluate data.

Name:_____ Date:_____

INT-E4
Evaluate Collected Data
Self-Assessment

1. Define data.

_____
_____
_____

2. Define calibration procedure.

_____
_____
_____

3. Define JPM.

_____
_____
_____

4. Define installation guide.

_____
_____
_____

5. Define maintenance guide.

_____
_____
_____

INT-E4
Evaluate Collected Data
Self-Assessment Answer Key

1. Information of any type.

2. Procedure followed to bring quality measured close to standard used.

3. Job performance measure.

4. Written instructions on how to install a device.

5. Written instruction on how to maintain a device.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-E5

Subject: Instrumentation **Time: 3 Hrs.**

Duty: Collect And File Data
Task: Review/Revise Procedures if Needed

Objective(s):

Upon completion of this module the student will be able to:

a. Review procedures;
b. Revise procedures; and,
c. Develop procedures.

Instructional Materials:

Sample procedures
MASTER Handout (INT-E5-HO)
MASTER Laboratory Aid (INT-E5-LA)
MASTER Laboratory Worksheet (INT-E5-LW)

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-E4 "Evaluate Collected Data"

Introduction:

Written procedures, followed closely are important to maintain consistency in product production.

Presentation Outline:

I. Define Procedures
II. Major Parts of Procedures
III. Compare Procedures to Lesson Plan

Practical Application:

Student will demonstrate how to write a procedure.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-E6) dealing with writing reports required by company.

INT-E5-HO
Review/Revise Procedures if Needed
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Review procedures;
b. Revise procedures; and,
c. Develop procedures.

Reading Assignments:

None - Company specific

Module Outline:

I. Define Procedures
II. Major Parts of Procedures
III. Compare Procedures to Lesson Plan

INT-E5-LA
Review/Revise Procedures if Needed
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Student will demonstrate how to write a procedure.

INT-E5-LW
Review/Revise Procedures if Needed
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Review procedures;
   b. Revise procedures; and,
   c. Develop procedures.

2. Student will demonstrate how to:
   a. Review procedures;
   b. Revise procedures; and,
   c. Develop procedures.

3. Instructor will grade student's ability to:
   a. Review procedures;
   b. Revise procedures; and,
   c. Develop procedures.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-E6

Subject: Instrumentation **Time: 2 Hrs.**

Duty: Collect And File Data
Task: Write Reports Required by Company

Objective(s):

Upon completion of this module the student will be able to write reports required by company.

Instructional Materials:

MASTER Handout (INT-E6-HO)
MASTER Laboratory Worksheet (INT-E6-LW)

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-E5 "Review/Revise Procedures if Needed"

Introduction:

Companies may require many or a few reports. This technical modules deals with some reports than an instrumentation technician may be required to write.

Presentation Outline:

I. Define Technical Reports
II. Cover Sheet

III. Table of Contents
IV. Purpose
V. Scope
VI. Calculation
VII. Charts
VIII. Results
IX. References

Practical Application:

Student will demonstrate how to write reports.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-E7) dealing with specifying equipment for control systems.

INT-E6-HO
Write Reports Required by Company
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to write reports required by company.

Module Outline:

I. Define Technical Reports
II. Cover Sheet
III. Table of Contents
IV. Purpose
V. Scope
VI. Calculation
VII. Charts
VIII. Results
IX. References

INT-E6-LW
Write Reports Required by Company
Attachment 2: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to write a technical report required by the company.

2. Student will demonstrate how to write a technical report required by the company.

3. Instructor will grade student's ability to write a technical report required by the company.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-E7

Subject: **Instrumentation** **Time: 35 Hrs.**

Duty: **Collect and File Data**
Task: Specify Equipment for Control Systems

Objective(s):

Upon completion of this module the student will be able to specify and use:

a. Control relay;
b. Magnetic starter;
c. Reduced voltage starter;
d. Inputs; and,
e. Outputs.

Instructional Materials:

Control relay
Magnetic starter
Reduced voltage starter
Inputs
Outputs
MASTER Handout (INT-E7-HO)
MASTER Laboratory Aid (INT-E7-LA)
MASTER Laboratory Worksheet (INT-E7-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:

INT-E6 "Write Reports Required by Company"

Introduction:

The amount of knowledge that an instrumentation technician must exhibit is increasing. Controls provide dependable and reliable service. Control technology is very important to today's industry.

Presentation Outline:

I. Introduction, Overview, General Principles of Motor Control, DC, Single Phase, Three Phase
II. Fractional HP Manual Motor Starters, Magnetic Motor Starters, Motors-DC, Single Phase And Three Phase
III. Push-Button Control, Relays, Contactors, and Magnetic Starters, Ladder Diagram
IV. Timing Relays, Counters
V Pressure Switches, Float Switches, Limit Switches, Two Wire Control, Three Wire Control Multiple Push-Button Stations
VI. Jog Control, Hand-Off Automatic Control, Drum Switch
VII. Sequence Control

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-E8) dealing with preparing and updating specification forms.

INT-E7-HO
Specify Equipment for Control Systems
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to specify and use:

a. Control relay;
b. Magnetic starter;
c. Reduced voltage starter;
d. Inputs; and,
e. Outputs.

Reading Assignments:

Industrial Motor Control, Alerich, Delmar Publishers, Latest Edition:

Chapter	Title
2	Motor Starters
3	Control Circuits
4	Basic Control Circuits
5	DC Motor Controls
6	AC Motor Controls
7	Motor Drives

Module Outline:

I. Introduction, Overview, General Principles of Motor Control, DC, Single Phase, Three Phase
II. Fractional HP Manual Motor Starters, Magnetic Motor Starters, Motors-DC, Single Phase And Three Phase

III. Push-Button Control, Relays, Contactors, and Magnetic Starters, Ladder Diagram
IV. Timing Relays, Counters
V Pressure Switches, Float Switches, Limit Switches, Two Wire Control, Three Wire Control Multiple Push-Button Stations
VI. Jog Control, Hand-Off Automatic Control, Drum Switch
VII. Sequence Control

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-E7-LW
Specify Equipment for Control Systems
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to properly use:
   a. Single phase and three phase;
   b. Fractional HP manual motor starters, magnetic motor starters, motors-DC, single phase and three phase;
   c. Push-button control, relays, contactors & magnetic starters, ladder diagram;
   d. Timing relays, counters;
   e. Pressure switches, float switches, limit switches, two wire control, three wire control multiple push-button stations;
   f. Jog control, hand-off automatic control, drum switch; and,
   g. Sequence control.

2. Student will demonstrate how to properly use:
   a. Single phase and three phase;
   b. Fractional HP manual motor starters, magnetic motor starters, motors-DC, single phase and three phase;
   c. Push-button control, relays, contactors & magnetic starters, ladder diagram;
   d. Timing relays, counters;
   e. Pressure switches, float switches, limit switches, two wire control, three wire control multiple push-button stations;
   f. Jog control, hand-off automatic control, drum switch; and,
   g. Sequence control.

3. Instructors will grade student's ability to properly use:
   a. Single phase and three phase;
   b. Fractional HP manual motor starters, magnetic motor starters, motors-DC, single phase and three phase;
   c. Push-button control, relays, contactors & magnetic starters, ladder diagram;
   d. Timing relays, counters;
   e. Pressure switches, float switches, limit switches, two wire control, three wire control multiple push-button stations;
   f. Jog control, hand-off automatic control, drum switch; and,
   g. Sequence control.

Name:_____ Date:_____

INT-E7
Specify Equipment for Control Systems
Self-Assessment

1. An AC controller uses _____ power to supply its control devices and circuitry.
   a. DC
   b. Rectified AC
   c. Three phase AC
   d. Single phase AC

2. AC controllers are used because _____.
   a. They have no movable parts
   b. AC electromechanical devices work better that DC ones
   c. The majority of industrial motors operate from DC power
   d. The majority of industrial motors operate from AC power

3. A typical AC controller is made up of three devices. They are _____.
   a. A knife switch, rheostat, and heater elements
   b. A contactor, overload relay, and heater elements
   c. A rheostat, contactor, and overload relay
   d. A contactor, overload relay, and armature

4. _____ starting uses a motor circuit that utilizes some sections of a transformer in order to produce reduced-voltage starting.
   a. Autotransformer
   b. Reactor
   c. Isolation transformer
   d. Potential transformer

5. Additional motor-starting current can be supplied by a bank of _____ in the circuit.
   a. Resistors
   b. Transistors
   c. Control relays
   d. Capacitors

6. A _____ is a device that resists the change in the flow of current but allows current flow to increase gradually.
   a. Reactor
   b. Resistor
   c. Thermocouple
   d. Isolation transformer

7. In some induction motors, you can control motor speed by reducing the applied _____ without losing torque.
   a. Voltage
   b. Voltage and frequency
   c. Frequency
   d. Magnetic force

8. Reduced-voltage starting eliminates problems in _____.
   a. The power source
   b. The motor
   c. The circuit wiring
   d. All of the above

9. The purpose pf am interlock is to prevent the _____ and _____ circuits from being closed at the same time.
   a. Forward, reverse
   b. AC, DC
   c. Three phase AC, single phase AC
   d. Inductive, capacitive

10. Motor branch circuits must have over current-protection devices capable of carrying the _____ current of the motor.
   a. Full load
   b. Armature
   c. Starting
   d. Field

11. Explain what a thermocouple is.
   a. A device that converts pressure to electric current.
   b. A device that converts electric current into pressure.
   c. A device that converts electric current into heat.
   d. A device that converts heat to electrical current.

12. Describe the difference between a solid-state relay and an electromechanical relay.
    a. Solid state relays have one coil, electromagnetic relays have two coils.
    b. Solid state relays are small, electromagnetic relays are large.
    c. Solid state relays use vacuum tubes, electromagnetic relays do not use vacuum tubes.
    d. Solid state relays have no moving parts, electromechanical relays do have moving parts.

13. List the three categories of proximity switches.
    a. Inductive, capacitive, ultrasonic
    b. Resistive, inductive, capacitive
    c. Photoelectric, resistive, inductive
    d. Ultrasonic, photoelectric, inductive

14. State the basic function of a photoelectric switching device.
    a. They cause rapid switching when turned on.
    b. They cause switching when placed near a magnetic source.
    c. They cause switching to occur after the device detector changes in light color.
    d. They cause switching to occur after the device detector changes in light intensity.

15. State the function of a proximity switch.
    a. To detect the presence of an object by making contact with the object.
    b. To detect the presence if an object by photoelectric concepts.
    c. To detect the presence of an object by ultrasonic methods.
    d. To detect the presence of an object without making contact with the object.

INT-E7
Specify Equipment for Control Systems
Self-Assessment Answer Key

1. d
2. d
3. b
4. a
5. a
6. a
7. b
8. d
9. a
10. c
11. d
12. d
13. a
14. d
15. d

INSTRUMENTATION SERIES

MASTER Technical Module NO. INT-E8

Subject: **Instrumentation** **Time: 3 Hrs.**

Duty: **Collect and File Data**
Task: Prepare and Update Specification Forms

Objective(s):

Upon completion of this module the student will be able to:
a. Prepare specification forms; and,
b. Update specification forms.

Instructional Materials:

Sample specifications
MASTER Handout (INT-E8-HO)
MASTER Laboratory Worksheet (INT-E8-LW)

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-E7 "Specify Equipment for Control Systems"

Introduction:

Specifications are a list of requirement that must be met when making a product. Specifications are used to set limits on products. A knowledge of the equipment used to manufacture the product is important. This module deals with preparing a specification form.

Presentation Outline:

I. General
II. Specific Structure
III. Assembly
IV. Tests
V. Criteria

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-E9) dealing with writing work orders.

INT-E8-HO
Prepare and Update Specification Forms
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to:

a. Prepare specification forms; and,
b. Update specification forms.

Module Outline:

I. General
II. Specific Structure
III. Assembly
IV. Tests
V. Criteria

---

1. Instructor will demonstrate how to write a specification:
   a. General;
   b. Specific structure;
   c. Assembly;
   d. Tests; and,
   e. Criteria.

2. Student will demonstrate how to write a specification:
   a. General;
   b. Specific structure;
   c. Assembly;
   d. Tests; and,
   e. Criteria.

3. Instructor will grade student's ability to write a specification:
   a. General;
   b. Specific structure;
   c. Assembly;
   d. Tests; and,
   e. Criteria.

INT-E9

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-E9

Subject: Instrumentation **Time:** 2 Hrs.

Duty: Collect and File Data
Task: Write Work Orders

Objective(s):

Upon completion of this module the student will be able to write work orders.

Instructional Materials:

Sample work order
MASTER Handout (INT-E9-HO)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-E8 "Prepare and Update Specification Forms"

Introduction:

Work orders provide a communication means between one person and another person. The reason for work orders is to request work to be performed. This module deals with work orders.

Presentation Outline:

I. Define Work Order

II. Major Section of Work Order
III. Proper Signatures
IV. Work Order Classification
V. Completion Anticipated Date
VI. Actual Completion Date
VII. Work Order vs. Maintenance Log
VIII. Work Order Statistics
IX. Prioritize
X. Plan and Schedule

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-F1) dealing with reading/interpreting diagrams and drawings.

INT-E9-HO
Write Work Orders
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to write work orders.

Reading Assignments:

Handbook of Modern Manufacturing Management, Magnard, McGraw-Hill Publishers, Latest Edition:

Chapter	**Title**
102-125	Work Order

Also, refer to plant specific materials.

Module Outline:

I. Define Work Order
II. Major Section of Work Order
III. Proper Signatures
IV. Work Order Classification
V. Completion Anticipated Date
VI. Actual Completion Date
VII. Work Order vs. Maintenance Log
VIII. Work Order Statistics
IX. Prioritize
X. Plan and Schedule

Name:_____ Date:_____

INT-E9
Write Work Orders
Self-Assessment

1. List major sections of work order.

_____
_____
_____

2. Define work order.

_____
_____
_____

3. How can work orders be placed in a computer database?

_____
_____
_____

4. What signatures are required on a work order?

_____
_____
_____

INT-E9
Write Work Orders
Self-Assessment Answer Key

1. Work to be done, reason, special instructions, work done, dates, signature department, charge to, rates, hours.

2. Work request.

3. Use work order software (database).

4. Originator, approved by, completed by.

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simu-late control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and re-pair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and re-pair transmit-ters	C-12 Test dif-ferent field sensing ele-ments, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Cali-brate trans-mitters	C-15 Tune controllers: pneumatic and electronic	C-16 Trouble-shoot and re-pair plant com-puting systems relating to pro-cess controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and re-pair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and con-figure smart field devices, i.e., transmit-ters and valves	C-35 Operate control systems including single element, cas-cade, ratio, and feedforeward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Deter-mine proper tools, equip-ment, and ma-terials to per-form the job	D-3 Coordi-nate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment iso-lation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibra-tion proce-dures	D-8 Follow specifications and proce-dures	D-9 Perform algebraic op-erations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibra-tion data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise proce-dures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Applica-tion of ISA/IEC standards	F-5 Under-stand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Under-stand personal computers	F-10 Attend on-going safety training courses	F-11 Partici-pate in plant related train-ing	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLC's	H-8 Trouble-shoot, install, maintain and operate PLCs					

INT-F1

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-F1

Subject: **Instrumentation** **Time: 20 Hrs.**

Duty: **Participate in Continuing Education Activities**
Task: Read/Interpret Diagrams and Drawings

Objective(s):

Upon completion of this module the student will be able to:

a. Read single line diagrams;
b. Interpret single line diagrams;
c. Read schematic diagrams;
d. Interpret schematic diagrams;
e. Read wiring diagrams;
f. Interpret wiring diagrams;
g. Read ladder diagrams;
h. Interpret ladder diagrams;
i. Read process diagrams;
j. Interpret process diagrams;
k. Read logic diagrams; and,
l. Interpret logic diagrams.

Instructional Materials:

Single line diagram
Schematic diagrams
Wiring diagrams
Ladder diagrams
Process diagrams
Logic diagrams
MASTER Handout (INT-F1-HO)
MASTER Laboratory Aid (INT-F1-LA)
MASTER Laboratory Worksheet (INT-F1-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition

Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-E9 "Write Work Orders"

Introduction:

Understanding diagrams is a must for an instrumentation technician. Important information is conveyed by these diagrams.

Presentation Outline:

I. Single Line Diagrams
II. Schematic Diagrams
III. Wiring Diagrams
IV. Ladder Diagrams
V. Process Diagrams
VI. Logic Diagrams

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-F2) dealing with sketching diagrams.

INT-F1-HO

Read/Interpret Diagrams and Drawings

Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Read single line diagrams;
b. Interpret single line diagrams;
c. Read schematic diagrams;
d. Interpret schematic diagrams;
e. Read wiring diagrams;
f. Interpret wiring diagrams;
g. Read ladder diagrams;
h. Interpret ladder diagrams;
i. Read process diagrams;
j. Interpret process diagrams;
k. Read logic diagrams; and,
l. Interpret logic diagrams.

Reading Assignments:

Instrumentation, Kirk, ATP Publishers, Latest Edition:

Chapter	**Title**
Appendix A	Instrumentation Symbols
Appendix B	Electrical Symbols

Module Outline:

I. Single Line Diagrams
II. Schematic Diagrams

III. Wiring Diagrams
IV. Ladder Diagrams
V. Process Diagrams
VI. Logic Diagrams

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-F1-LW
Read/Interpret Diagrams and Drawings
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Read single line diagrams;
   b. Interpret single line diagrams;
   c. Read schematic diagrams;
   d. Interpret schematic diagrams;
   e. Read wiring diagrams;
   f. Interpret wiring diagrams;
   g. Read ladder diagrams;
   h. Interpret ladder diagrams;
   i. Read process diagrams;
   j. Interpret process diagrams;
   k. Read logic diagrams; and,
   l. Interpret logic diagrams.

2. Student will practice how to:
   a. Read single line diagrams;
   b. Interpret single line diagrams;
   c. Read schematic diagrams;
   d. Interpret schematic diagrams;
   e. Read wiring diagrams;
   f. Interpret wiring diagrams;
   g. Read ladder diagrams;
   h. Interpret ladder diagrams;
   i. Read process diagrams;
   j. Interpret process diagrams;
   k. Read logic diagrams; and,
   l. Interpret logic diagrams.

3. Instructor will grade the student's ability to:
   a. Read single line diagrams;
   b. Interpret single line diagrams;
   c. Read schematic diagrams;
   d. Interpret schematic diagrams;
   e. Read wiring diagrams;
   f. Interpret wiring diagrams;
   g. Read ladder diagrams;
   h. Interpret ladder diagrams;
   i. Read process diagrams;
   j. Interpret process diagrams;

k. Read logic diagrams; and,
l. Interpret logic diagrams.

Name:_____ Date:_____

INT-F1
Read/Interpret Diagrams and Drawings
Self-Assessment

1. What is a single line diagram?

_____
_____
_____

2. What is a schematic diagram?

_____
_____
_____

3. What is a ladder diagram?

_____
_____
_____

4. What is a P&ID diagram?

_____
_____
_____

5. What is a wiring diagram?

_____
_____
_____

INT-F1
Read/Interpret Diagrams and Drawings
Self-Assessment Answer Key

1. This diagram is used by power companies to show many miles of lines and electrical devices used. Usually these lines are drawn as a single line with crosshatches equal to the number of conductors.

2. Use symbols and lines to connect symbols. No scale.

3. Use symbols. Power drawn as vertical rails. Loads drawn as parallel rungs. No scale.

4. Use symbols unique to process industry.

5. Use symbols, however, components shown as they are physically placed.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-F2

Subject: **Instrumentation** **Time: 15 Hrs.**

Duty: **Participate in Continuing Education Activities**
Task: Sketch Diagrams

Objective(s):

Upon completion of this module the student will be able to:

a. Sketch single line diagrams;
b. Sketch schematic diagrams;
c. Sketch wiring diagrams;
d. Sketch ladder diagrams;
e. Sketch logic diagrams; and,
f. Sketch process diagrams.

Instructional Materials:

Single line diagram
Schematic diagram
Wiring diagram
Ladder diagram
Logic diagram
Process diagram
MASTER Handout (INT-F2-HO)
MASTER Laboratory Aid (INT-F2-LA)
MASTER Laboratory Worksheet (INT-F2-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-F1 "Read/Interpret Diagrams and Drawings"

Introduction:

Diagrams are a very useful tool to convey information from person to person.

Presentation Outline:

I. Schematic Diagrams
II. Logic Diagrams
III. Ladder Diagrams
IV. Wiring Diagrams
V. Single Line Diagrams
VI. Process Diagrams

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-F3) dealing with studying technical equipment information.

INT-F2-HO
Sketch Diagrams
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Sketch single line diagrams;
b. Sketch schematic diagrams;
c. Sketch wiring diagrams;
d. Sketch ladder diagrams;
e. Sketch logic diagrams; and,
f. Sketch process diagrams.

Reading Assignments:

Instrumentation, Kirk, ATP Publishers, Latest Edition:

Chapter	**Title**
Appendix A	Instrumentation Symbols
Appendix B	Electrical Symbols

Module Outline:

I. Schematic Diagrams
II. Logic Diagrams
III. Ladder Diagrams
IV. Wiring Diagrams
V. Single Line Diagrams
VI. Process Diagrams

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-F2-LW
Sketch Diagrams
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to sketch:
   a. Schematic diagrams;
   b. Logic diagrams;
   c. Ladder diagrams;
   d. Wiring diagrams;
   e. Single line diagrams; and,
   f. Process diagrams.

2. Student will practice how to sketch:
   a. Schematic diagrams;
   b. Logic diagrams;
   c. Ladder diagrams;
   d. Wiring diagrams;
   e. Single line diagrams; and,
   f. Process diagrams.

3. Instructor will grade student by the student's ability to sketch.
   a. Schematic diagrams;
   b. Logic diagrams;
   c. Ladder diagrams;
   d. Wiring diagrams;
   e. Single line diagrams; and,
   f. Process diagrams.

Name:_____ Date:_____

INT-F2
Sketch Diagrams
Self-Assessment

1. What is a schematic diagram?

2. What is a logic diagram?

3. What is a ladder diagram.

4. What is a wiring diagram.

5. What is a single line diagram.

6. What is a process diagram.

INT-F2
Sketch Diagrams
Self-Assessment Answer Key

1. A diagram that uses symbols and no scale to show the electrical devices.

2. Uses logic gates and truth tables to describe a circuit. This is electron.

3. Ladder diagram is a special type of schematic diagram that uses rails to indicate supply and rungs to indicate the circuit.

4. A special schematic diagram that is drawn in a pictorial manner.

5. This diagram uses symbols and one line to indicate one or more transmission or distribution lines. Used by power companies to show their power line.

6. The diagram uses symbols that is unique to the process industry. The symbols used are standardized by ISA.

INT-F3

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-F3

Subject: Instrumentation **Time: 3 Hrs.**

Duty: Participate in Continuing Education Activities
Task: Study Technical Equipment Information

Objective(s):

Upon completion of this module the student will be able to demonstrate knowledge of technical equipment through study of technical equipment information.

Instructional Materials:

Sample technical equipment information sheet or brochure
MASTER Handout (INT-F3-HO)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-F2 "Sketch Diagrams"

Introduction:

Technical equipn.ent information may be difficult to understand. A through knowledge of the basics of the equipment is a must in order to gain a degree of understanding of how to use the equipment.

Presentation Outline:

I. Introduction
II. General
III. Specific Dimensions
IV. Specific Tolerances
V. How to Use

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-F4) dealing with application of ISA/JIC standards.

INT-F3-HO
Study Technical Equipment Information
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to demonstrate knowledge of technical equipment through study of technical equipment information.

Module Outline:

I. Introduction
II. General
III. Specific Dimensions
IV. Specific Tolerances
V. How to Use

Name:_____ Date:_____

INT-F3
Study Technical Equipment Information
Self-Assessment

1. Instructor will pick an example, go through the example.
   a. Introduction;
   b. General;
   c. Specific dimensions;
   d. Specific tolerances; and,
   e. How to use.

2. Instructor will grade student's knowledge of that sample specification.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-F4

Subject: Instrumentation **Time:** 4 Hrs.

Duty: Participate in Continuing Education Activities
Task: Application of ISA/JIC Standards

Objective(s):

Upon completion of this module the student will be able to:
a. Apply ISA standards to instrumentation; and,
b. Apply JIC standards to instrumentation.

Instructional Materials:

Computer with Internet access
MASTER Handout (INT-F4-HO)
MASTER Laboratory Aid (INT-F4-LA)
MASTER Laboratory Worksheet (INT-F4-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-F3 "Study Technical Equipment Information"

Introduction:

Instrument Society America (ISA) plays a major in education, certification, and membership chapters. Joint Industry Council (JIC) has a similar mission.

Presentation Outline:

I. Define ISA
II. Purpose of ISA
III. ISA Functions
IV. Define JIC
V. Purpose of JIC
VI. JIC Functions

Practical Application:

Student will demonstrate how to apply ISA/JIC standards.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-F5) dealing with understanding proper use of test equipment and tools.

INT-F4-HO
Application of ISA/JIC Standards
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the computer lab by not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Apply ISA standards to instrumentation; and,
b. Apply JIC standards to instrumentation.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	**Title**
Appendix A	ISA Symbols

Module Outline:

I. Define ISA
II. Purpose of ISA
III. ISA Functions
IV. Define JIC
V. Purpose of JIC
VI. JIC Functions

Standards of performance safety:

Student shall demonstrate safe work habits in the computer lab by not participating in horse play or practical joking.

INT-F4-LW
Application of ISA/JIC Standards
Attachment 3: MASTER Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Access the Internet;
   b. Access ISA (www.isa.org);
   c. Explore functions of ISA through the Internet; and,
   d. Repeat procedure for JIC.

2. Student will demonstrate how to:
   a. Access the Internet;
   b. Access ISA (www.isa.org);
   c. Explore functions of ISA through the Internet; and,
   d. Repeat procedure for JIC.

3. Instructor will grade student's ability to:
   a. Access the Internet;
   b. Access ISA (www.isa.org);
   c. Explore functions of ISA through the Internet; and,
   d. Repeat procedure for JIC.

Name:_____ Date:_____

INT-F4
Application of ISA/JIC Standards
Self-Assessment

1. Define ISA.

2. Purpose of ISA.

3. ISA functions.

4. Define JIC.

5. Purpose of JIC.

6. How to access ISA by Internet?

INT-F4
Application of ISA/JIC Standards
Self-Assessment Answer Key

1. Instrument Society of America.
2. U.S. society of instrument and control professionals.
3. Provide standards, symbols and training for process control industry.
4. Joint Industry Council.
5. Standards for industry.
6. www.isa.org/

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-F5

Subject: **Instrumentation** **Time: 6 Hrs.**

Duty: **Participate in Continuing Education Activities**
Task: Understand Proper Use of Test Equipment and Tools

Objective(s):

Upon completion of this module the student will be able to:
a. Demonstrate proper use of test equipment; and,
b. Demonstrate proper use of tools.

Instructional Materials:

Test equipment
Tools
MASTER Handout (INT-F5-HO)
MASTER Laboratory Aid (INT-F5-LA)
MASTER Laboratory Worksheet (INT-F5-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-F4 "Application of ISA/JIC Standards"

Introduction:

Test equipment is expensive. Proper use ensures longer life for test equipment and less costs to the technician, company and customer. The same applies to tools that an instrumentation technician would use.

Presentation Outline:

I. Define Hand Tools
   - A. Hammer
   - B. Wrenches
   - C. Pliers
   - D. Screwdriver
   - E. Socket
   - F. Socket Wrench
   - G. Wire Cutters
   - H. Wire Strippers

II. Define Power Tools
   - A. Drill
   - B. Sanders

III. Define Test Equipment
   - A. Scope
   - B. DMM
   - C. Pressure Source
   - D. Calibrator
   - E. Clamp on Ammeter
   - F. Insulation Tester

Practical Application:

1. Demonstrate proper use of test equipment.
2. Demonstrate proper use of tools.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-F6) dealing with learning to write technical reports.

INT-F5-HO
Understand Proper Use of Test Equipment and Tools
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Demonstrate proper use of test equipment; and,
b. Demonstrate proper use of tools.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

The entire book

Module Outline:

I. Define Hand Tools
   A. Hammer
   B. Wrenches
   C. Pliers
   D. Screwdriver
   E. Socket
   F. Socket Wrench
   G. Wire Cutters
   H. Wire Strippers
II. Define Power Tools
   A. Drill
   B. Sanders
III. Define Test Equipment
   A. Scope

B. DMM
C. Pressure Source
D. Calibrator
E. Clamp on Ammeter
F. Insulation Tester

INT-F5-LA
Understand Proper Use of Test Equipment and Tools
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Demonstrate proper use of test equipment; and,
   c. Demonstrate proper use of tools.

INT-F5-LW
Understand Proper Use of Test Equipment and Tools
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate proper use of:
   a. Hand Tools;
      (1) Hammer;
      (2) Wrenches;
      (3) Pliers;
      (4) Screwdriver;
      (5) Socket;
      (6) Socket wrench;
      (7) Wire cutters;
      (8) Wire strippers;
   b. Power Tools;
      (1) Drill;
      (2) Sanders;
   c. Test Equipment;
      (1) Scope;
      (2) DMM;
      (3) Pressure source;
      (4) Calibrator;
      (5) Clamp on ammeter; and,
      (6) Insulation tester.

2. Student will demonstrate proper use of:
   a. Hand Tools;
      (1) Hammer;
      (2) Wrenches;
      (3) Pliers;
      (4) Screwdriver;
      (5) Socket;
      (6) Socket wrench;
      (7) Wire cutters;
      (8) Wire strippers;
   b. Power Tools;
      (1) Drill;
      (2) Sanders;
   c. Test Equipment;
      (1) Scope;
      (2) DMM;
      (3) Pressure source;
      (4) Calibrator;

(5) Clamp on ammeter; and,
(6) Insulation tester.

3. Instructor will grade student's ability to:
   a. Hand Tools;
      (1) Hammer;
      (2) Wrenches;
      (3) Pliers;
      (4) Screwdriver;
      (5) Socket;
      (6) Socket wrench;
      (7) Wire cutters;
      (8) Wire strippers;
   b. Power Tools;
      (1) Drill;
      (2) Sanders;
   c. Test Equipment;
      (1) Scope;
      (2) DMM;
      (3) Pressure source;
      (4) Calibrator;
      (5) Clamp on ammeter; and,
      (6) Insulation tester.

Name:_____ Date:_____

INT-F5
Understand Proper Use of Test Equipment and Tools
Self-Assessment

1. A/an _____ is sensitive to very low levels of current leakage to ground.
   A. ground-fault interrupter
   B. magnetic breaker
   C. thermal breaker
   D. adjustable inductor

2. A ground fault outlet is designed to trip at:
   A. an overload of 16 to 21 amps.
   B. any fault current.
   C. any over current.
   D. a fault current from 4 milliamps to 6 milliamps.

3. Painful shock begins at 8 mA and muscle control is lost at 15 mA. For a person with dry, uninjured skin, body resistance may be 8,000 ohms. If current enters through one hand and leaves through the other hand at 120 volts, using Ohms law, indicate below if not muscle control will be lost.
   A. Yes! Current is 15 mA.
   B. Yes! Current exceeds 20 mA
   C. No! Current is 10 mA.
   D. No!. Current is 6mA.

4. Before checking for a shorted or grounded circuit, one should:
   A. turn off all power to unit.
   B. replace all fuses.
   C. connect the ohmmeter in series with the load.
   D. All the above.

5. If it is necessary to test a "live" electrical circuit, you should:
   A. use only one hand.
   B. turn power off if possible.
   C. test your meter on a known source of power.
   D. A, B and C.
   E. B. and C. only.

6. The _____ physically prohibits the operation of a piece of equipment.
   A. GFCI
   B. tagout device
   C. lockout device
   D. A, B, and C.

7. The _____ does not physically prohibit operation of equipment; it relies on those who read it.
   A. GFCI
   B. tagout device
   C. Lockout device
   D. A, B, and C

8. Zero energy means all forms of energy (electrical, mechanical, fluid, and thermal) are neutralized.
   A. True
   B. False

9. When is it safe to work on a suspended load?
   A. Never.
   B. When the part being fixed is on the bottom.
   C. When your supervisor says no.
   D. After the hoist or chain has been inspected.

10. Personal protective equipment is special equipment:
   A. to be used at your discretion.
   B. that prevents accidents.
   C. purchased by the employee.
   D. that you must wear in dangerous situations.

11. A noise level between _____ decibels is most dangerous because it is not painful to the normal ear.
   A. 70-90
   B. 90-130
   C. 130-140
   D. 140-160

12. In double insulated tools, protection against electric shock is provided by the:
   A. two-wire supply cord
   B. three-wire supply cord
   C. insulated case or liner
   D. grounding lug

13. The lug on the adapter for a three-prong plug:
    A. eliminates sparks
    B. completes the grounding circuit
    C. replaces the GFCI
    D. increases the line to line resistance

14. The green grounding wire on electric tools:
    A. is not grounded to the tool.
    B. completes the electrical circuit.
    C. is a part of the switch circuit.
    D. connects to the tool's metal frame.

15. Which of the following kinds of ladders should you AVOID using around electrical equipment?
    A. extension
    B. step
    C. metal
    D. wooden

16. Which of the following does NOT carry current during normal operation of a circuit?
    A. grounded wire
    B. grounding wire
    C. natural grey wire
    D. white wire

17. Under normal operating conditions, in addition to you, who is allowed to remove your padlock from a machine's power source after a power lockout?
    A. no one
    B. the maintenance supervisor
    C. the safety engineer
    D. your supervisor

18. An electrical shock victim is frozen to the source of the shock; the FIRST thing you should do is:
    A. pull the person away from the conductor
    B. send for medical assistance
    C begin CPR
    D. shut off the electricity
    E. go for help
    F. shout for help

INT-F5
Understand Proper Use of Test Equipment and Tools
Self-Assessment Answer Key

1. A
2. D
3. A
4. A
5. D
6. C
7. B
8. A
9. A
10. D
11. A
12. C
13. B
14. D
15. C
16. B
17. A
18. D

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-F6

Subject: Instrumentation **Time: 30 Hrs.**

Duty: Participate in Continuing Education Activities
Task: Learn to Write Technical Reports

Objective(s):

Upon completion of this module the student will be able to:

a. Write technical reports;
b. Conduct research;
c. Develop technical report;
d. Prepare memo; and,
e. Present technical report.

Instructional Materials:

Sample technical report
Overhead
Computer with desktop publishing software (optional)
MASTER Handout (INT-F6-HO)
MASTER Laboratory Worksheet (INT-F6-LW)
MASTER Self-Assessment

References:

Technically Write! Communicating in a Technological Era, Blicq, R.S., Englewood Cliffs, NJ: Prentice Hall, Latest Edition
Harbrace College Handbook, Hodges H.C., et al., San Diego: Harcourt Brace Jovanovich, Latest Edition
Reporting Technical Information, Houp K.W., & Pearsall, New York: Macmillan, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-F5 "Understand Proper Use of Test Equipment and Tools"

Introduction:

Technical reports convey technical information about a device into a written format so that others can read and digest this information.

Presentation Outline:

I. Define Technical Report
II. Grammar/Composition Review
III. Language Usage-technical Communication
IV. Vocabulary
V. Idea Development
VI. Spelling
VII. Outlining
VIII. Sentence Elements
IX. Locating Information, Research Skills
X. Organizing Information
XI. Editing and Proofreading
XII. Construction of Reports
XIII. Graphic Use
XIV. Production of Technical Reports
XV. Presentation Skills

Practical Application:

Student will demonstrate how to write a technical report.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-F7) dealing with acquiring safe practices for handling hydraulic and special tools.

INT-F6-HO
Learn to Write Technical Reports
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Write technical reports;
b. Conduct research;
c. Develop technical report;
d. Prepare memo; and,
e. Present technical report.

Reading Assignments:

Technical Writing: A Practical Approach, William Pfeiffer, Prentice Hall, Latest Edition:

Chapter	Title
1	Process In Technical Writing
3	Organizing Information
9	Formal Reports
11	Graphics
13	Technical Research
15	Styles In Technical Writing

Module Outline:

I. Define Technical Report
II. Grammar/Composition Review
III. Language Usage-technical Communication
IV. Vocabulary

V. Idea Development
VI. Spelling
VII. Outlining
VIII. Sentence Elements
IX. Locating Information, Research Skills
X. Organizing Information
XI. Editing and Proofreading
XII. Construction of Reports
XIII. Graphic Use
XIV. Production of Technical Reports
XV. Presentation Skills

INT-F6-LW
Learn to Write Technical Reports
Attachment 2: **MASTER** Laboratory Worksheet

Guidelines for Instrumentation Notebook:

1. Use plain paper size 8 ½ x 11.
2. All lab report should be done on the computer. *Note:* Use any software programming that is available to you.
3. Only data gathered in the lab can be the same for the same group and the rest of lab report should be by each individual. Two exact lab reports I the same group will be graded zero.
4. Lab report must be complete, self-explanatory record of what you did, why you did it, what equipment was used for measurements, what each table of data represents, how the data was processed, what the results were, and any unexpected results that might warrant further investigation.
5. **Process**
   Collect data: chart, graphs
   Process data: calculations, measurement
   Evaluate data: conclusions
   Assemble the data: write the report
6. **Conclusion**
   What did you do?
   Why did you do it?
   What results were obtained?
7. **Format**

Cover Sheet (see the example)	(5 pts)
Table of Contents	(7 pts)
Purpose or Introduction	(12 pts)
Equipment and Parts Used	(10 pts)
Circuit Diagram	(12 pts)
Calculations	(22 pts)
Charts and Graphs	(17 pts)
Conclusion	(10 pts)
References	(5 pts)
	Total: (100 pts)

Augusta Tech
Instrumentation Technology

Course No: _____

Instructor: _____

Date: _____

Lab Title: _____

Lab No.: _____

Submitted by: _____

Lab Partner: _____

Lab Partner: _____

Instructor Evaluation and Comments:

_____
_____
_____
_____
_____
_____

Name:_____ Date:_____

INT-F6
Learn to Write Technical Reports
Self-Assessment

1. Define technical report

2. List some grammar/composition rules.

3. What are the three classifications of technical records?

4. What is an analytical report?

5. List outlining rules.

6. What are sentence elements?

7. List rules for locating information, research skills.

8. List rules for organizing information.

9. What is the last part of the report?

_____

_____

_____

10. List common construction of reports.

_____

_____

_____

INT-F6
Learn to Write Technical Reports
Self-Assessment Answer Key

1. An investigation to determine the suitability of materials, equipment on systems to perform a specific function.

2. Follow company rules that are unique to that company. Follow company format that is unique to that company.

3. Unlimited, limited and formal.

4. A mechanism, process or problem is analyzed.

5. I (etc.), A (etc.), 1 (etc.), a (etc.)

6. Major areas of sentence such as noun, verbs, adverbs.

7. Use library, use books, use Internet as resource tools.

8. Collect data, process data, evaluate data.

9. Conclusions

10. Cover, sheet, purpose

INT-F7

INSTRUMENTATION SERIES

MASTER Technical Module NO. INT-F7

Subject: Instrumentation **Time:** 15 Hrs.

Duty: Participate in Continuing Education Activities
Task: Acquire Safe Practices for Handling Hydraulic and Special Tools

Objective(s):

Upon completion of this module the student will be able to:
a. Demonstrate safe handling of hydraulic tools; and,
b. Demonstrate safe handling of special tools.

Instructional Materials:

Hydraulic tools
Special tools unique to your area
MASTER Handout (INT-F7-HO)
MASTER Laboratory Aid (INT-F7-LA)
MASTER Laboratory Worksheet (INT-F7-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-F6 "Learn to Write Technical Reports"

Introduction:

Lockout and tagout procedures stipulate zero energy from all forms of energy. Hydraulic accumulators store energy. All special tools must be handled correctly and safety. This module deals with these special considerations.

Presentation Outline:

I. Hydraulic Theory
II. Storage Devices
III. Pumps-Prime Movers
IV. Actuators
V. Control Devices
VI. Accumulators

Practical Application:

Student will demonstrate the safe use of:
a. Hydraulic tools; and,
b. The special tools.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-F8) dealing with utilizing technical manuals.

INT-F7-HO
Acquire Safe Practices for Handling Hydraulic and Special Tools
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Demonstrate safe handling of hydraulic tools; and,
b. Demonstrate safe handling of special tools.

Reading Assignments:

Industrial Hydraulics, Vickers, Latest Edition:

The entire book

Module Outline:

I. Hydraulic Theory
II. Storage Devices
III. Pumps-Prime Movers
IV. Actuators
V. Control Devices
VI. Accumulators

INT-F7-LA
Acquire Safe Practices for Handling Hydraulic and Special Tools
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Demonstrate the safe use of hydraulic tools; and,
   c. Demonstrate the safe use of the special tools.

INT-F7-LW
Acquire Safe Practices for Handling Hydraulic and Special Tools
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to use:
   a. Storage devices;
   b. Pumps-prime movers;
   c. Actuators;
   d. Control devices; and,
   e. Accumulators.

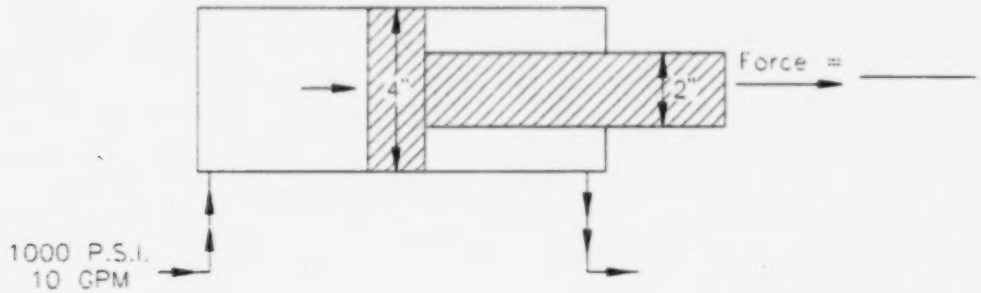
2. Student will demonstrate how to use:
   a. Storage devices;
   b. Pumps-prime movers;
   c. Actuators;
   d. Control devices; and,
   e. Accumulators.

3. Instructor will grade student's ability to use:
   a. Storage devices;
   b. Pumps-prime movers;
   c. Actuators;
   d. Control devices; and,
   e. Accumulators.

Name:_____ Date:_____

INT-F7
Acquire Safe Practices for Handling Hydraulic and Special Tools
Self-Assessment

1. The most important rule for tightening compression fittings is:
   a. Tighten only until snug, then check under pressure
   b. Always use two wrenches to tighten
   c. If a fitting leaks, tighten it 3 turns after the leak is stopped
   d. Always re-tighten all fittings



2. In the above diagram, what is the force generated (disregard friction)?
   A. 14560 lbs
   B. 13560 lbs
   C. 12560 lbs
   D. 11560 lbs

3. The most suitable type of tubing for high pressure is:
   A. copper
   B. aluminum
   C. steel
   D. plastic

4. Basic hydraulics theory tells us that pressure:
   A. on a confined liquid is transmitted undiminished in every direction
   B. acts with equal force on equal areas
   C. acts at right angles to the container walls
   D. acts with equal force on reduced areas

5. A pilot-operated relief valve provides:
   A. better system protection than direct-acting due to less pressure rise above "cracking"
   B. quiet operation and less chatter than direct-acting
   C. versatility - can be a safety relief, a remote-controlled relief, used in multiple relief systems and as a pump unloader
   D. all of the above

6. To keep a hydraulic system clean, one should periodically:
   A. replace the filters.
   B. adjust system pressure.
   C. replace control valves.
   D. add more fluid.

7. The relief valve in any fluid circuit:
   A. protects the system from excessively high pressures.
   B. protects the system from low pressures.
   C. directs oil from the pump to the cylinder.
   D. allows oil to flow in one direction only.

8. Hydraulic filters:
   A. filter to a lesser degree when they have been in service longer.
   B. filter to a higher degree when they have been in service longer.
   C. all have the same micron rating since nearly all hydraulic oils are the same.
   D. should be changed every other time.

9. Liquid pressure is measured in:
   A. PSI
   B. GPM
   C. KPM
   D. RPM

10. Hydraulics is the science of transmitting force or motion through a medium of a:
   A. confined liquid.
   B. non-confined liquid.
   C. all of the above.
   D. none of the above.

11. Before removing a hydraulic component:
   A. all connections should be thoroughly cleaned.
   B. the reservoir should be drained.
   C. the component should be drained.
   D. none of the above.

12. After installing and testing a hydraulic motor, it is found that it rotates in the wrong direction. The procedure for correcting this is to:
    A. reverse the electric motor leads.
    B. replace the motor.
    C. reverse the pump lines.
    D. reverse the motor lines.

13. A system malfunction has been traced to a bad pump. In addition to replacing the pump, one should also:
    A. replace the relief valve.
    B. adjust the main control valve.
    C. adjust the cylinder packing.
    D. find out what caused the pump to fail.

14. When installing a hydraulic pump, the piping connections to the pump must be:
    A. made first.
    B. made by the manufacturer.
    C. slightly oversized.
    D. free of leaks.

15. A hydraulic motor:
    A. converts mechanical force to hydraulic pressure.
    B. converts hydraulic pressure to mechanical force.
    C. delivers oil from the reservoir to the pump.
    D. receives oil from the reservoir and delivers it to the pump.

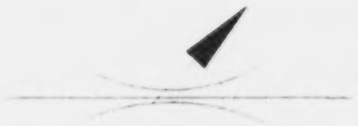
16. Cavitation occurs in a pump when:
    A. the fluid does not completely fill the space provided for it in the pump.
    B. the pressure from the output causes the pump to cease pumping action.
    C. the flow from the pump cannot be increased by increasing the RPM.
    D. the inlet is too large, allowing too much oil to the pump.

17. A series of component parts connected to each other by fluid lines in the hydraulic system is called a:
    A. closed center system.
    B. by pass.
    C. circuit.
    D. motor.

18. If the spring is broken in a relief valve, one should:
    A. replace it.
    B. leave it and continue to operate.
    C. check control valve.
    D. adjust linkages.

19. In a hydraulic system, flow is produced by the action of the:
    A. control valve.
    B. pump.
    C. relief valve.
    D. cylinder.

20. The following symbol represents a(n):
    A. pressure regulator.
    B. adjustable flow control.
    C. pressure compensator.
    D. none of the above.



21. The unit of measure of a filter's ability to block contaminants is the:
    A. micro-liter.
    B. micron.
    C. million.
    D. micro-foot.

22. A device built into the outlet of a cylinder to slow down the piston at the end of its stroke is called the:
    A. cushion.
    B. accumulator.
    C. activator.
    D. motor.

23. The three main types of hydraulic pumps are:
    A. gear, vane, and rotary.
    B. gear, piston, and vane.
    C. vane, gear, and variable.
    D. variable, gear, and piston.

24. The threaded pipe which should be used for hydraulics is:
    A. NPT (National Pipe Thread).
    B. APT (American Pipe Thread).
    C. NPTF (National Pipe Tight Fit).
    D. none of the above.

25. Excessive foaming in a hydraulic system often is caused by:
    A. a leak on the pressure side of the system.
    B. a leak on the suction side of the system.
    C. excessive system pressure.
    D. none of the above.

26. This symbol denotes a(n):
    A. fixed displacement pump.
    B. variable volume, pressure compensated pump.
    C. birotational variable volume, pressure compensated pump.
    D. none of the above.

27. A/An _____ filter has holes that are approximately the same size.
    a. absolute
    b. nominal
    c. particulate
    d. coalescent

28. In a filter, condensate:
    a. evaporates.
    b. mixes with the air.
    c. must be drained.
    d. lubricates the system.

INT-F7
Acquire Safe Practices for Handling Hydraulic and Special Tools
Self-Assessment Answer Key

1. A
2. C
3. A
4. D
5. A
6. A
7. A
8. A
9. A
10. C
11. D
12. D
13. D
14. B
15. A
16. C
17. A
18. B
19. B
20. B
21. A
22. B
23. C
24. B
25. B
26. B
27. C
28. C

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-F8

Subject: Instrumentation **Time: 2 Hrs.**

Duty: Participate in Continuing Education Activities
Task: Utilize Technical Manual

Objective(s):

Upon completion of this module the student will be able to utilize technical manuals.

Instructional Materials:

MASTER Handout (INT-F8-HO)
MASTER Laboratory Worksheet (INT-F8-LW)

References

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-F7 "Acquire Safe Practices for Handling Hydraulic and Special Tools"

Introduction:

Technical manuals are written to convey technical knowledge, skills and unique characteristics about a particular device. To be able to "talk the talk" is an important part of a technician's duties.

Presentation Outline:

I. Define Technical Manual
II. Major Sections of Technical Manual
III. Sample Technical Manual

Practical Application:

Using a sample technical manual, student will demonstrate how to properly use manual to gain technical information.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-F9) dealing with understanding personal computers.

INT-F8-HO
Utilize Technical Manuals
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to utilize technical manuals.

Module Outline:

I. Define Technical Manual
II. Major Sections of Technical Manual
III. Sample Technical Manual

INT-F8-LW
Utilize Technical Manuals
Attachment 2: **MASTER** Laboratory Worksheet

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1. Instructor will:
   a. Define technical manual;
   b. Describe major sections of technical manual; and,
   c. Show students sample technical manual.

2. Student will:
   a. Define technical manual;
   b. Describe major sections of technical manual; and
   c. Review sample technical manual.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-F9

Subject: **Instrumentation** **Time: 40 Hrs.**

Duty: **Participate in Continuing Education Activities**
Task: Understand Personal Computers

Objective(s):

Upon completion of this module the student will be able to:

a. List major parts of computer;
b. Demonstrate a working knowledge of keyboard;
c. Demonstrate a working knowledge of DOS;
d. Demonstrate a working knowledge of Windows 3.1; and,
e. Demonstrate a working knowledge of Windows 95.

Instructional Materials:

Computer (DOS, Windows, and Windows 95)
MASTER Handout (INT-F9-HO)
MASTER Laboratory Worksheet (INT-F9-LW)
MASTER Self-Assessment

References:

Learning To Use Microsoft Windows 3.1, Shelley Cashman, Forsythe,. Boyd and Fraser Publishing Company, Latest Edition
Learning To Use DOS, Shelly, Cashman, Forsythe; Boyd and Fraser Publishing Company, Latest Edition
Learning To Use Microsoft Word, Shelly, Cashman, Forsythe; Boyd and Fraser Publishing Company, Latest Edition
Learning To Use Windows 95, etc., Shelly, Cashman, Forsythe; Boyd and Fraser Publishing Company, Latest Edition
Learning To Use Microsoft Excel, etc., Shelly, Cashman, Forsythe; Boyd and Fraser Publishing Company, Latest Edition
Learning To Use Microsoft PowerPoint, etc., Shelly, Cashman, Forsythe; Boyd and Fraser Publishing Company, Latest Edition
Learning To Use Microsoft Access, etc., Shelly, Cashman, Forsythe; Boyd and Fraser Publishing Company, Latest Edition
Learning To Use BASIC, etc., Shelly, Cashman, Forsythe; Boyd and Fraser Publishing Company, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-F8 "Utilize Technical Manuals"

Introduction:

Software in computers in many cases may drive complex systems. These systems may run an entire plant. In many cases, this systems may be required to be operational seven (7) days a week, 24 hours a day. Therefore, familiarity with todays software is important.

Presentation Outline:

I. Major Parts of Digital and Analog Computer
II. Keyboard Skills
III. DOS
IV. Windows 3.1
V. Windows 95
VI. Word Processing Software
VII. Spreadsheet Software
VIII. Graphic Software
IX. Computer Languages

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-F10) dealing with attending on-going safety training courses.

INT-F9-HO
Understand Personal Computers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the computer lab by not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. List major parts of computer;
b. Demonstrate a working knowledge of keyboard;
c. Demonstrate a working knowledge of DOS;
d. Demonstrate a working knowledge of Windows 3.1; and,
e. Demonstrate a working knowledge of Windows 95.

Reading Assignments:

Using Computers, A Gateway of Information, Shelley, Boyd & Fraser Publishing Company, Latest Edition:

Chapter	Title
1	Overview
2	Software
4	System Unit

Module Outline:

I. Major Parts of Digital and Analog Computer
II. Keyboard Skills
III. DOS
IV. Windows 3.1
V. Windows 95
VI. Word Processing Software
VII. Spreadsheet Software
VIII. Graphic Software
IX. Computer Languages

INT-F9-LW
Understand Personal Computers
Attachment 2: **MASTER** Laboratory Worksheet

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1. Practice booting up a computer.
2. Practice properly powering down computer.
3. Practice using DOS commands.
4. Practice using Windows 3.1.
5. Practice using Windows 95.
6. Practice using a word processing software.
7. Practice using a spreadsheet software.
8. Practice using a graphic software.
9. Practice using a programming language.

Name:_____ Date:_____

INT-F9
Understand Personal Computers
Self-Assessment

1. Which Windows program is a drawing program?
   a. Paint brush
   b. Card file
   c. Write
   d. Terminal

2. Which Windows program is a word processor?
   a. Paint brush
   b. Card file
   c. Write
   d. Terminal

3. What is Windows ability to run more than one program at a time called?
   a. OLE
   b. GUI
   c. Integration
   d. Multi-tasking

4. Which program in the control panel lets you select wallpaper?
   a. Desktop
   b. Color
   c. Fonts
   d. Mouse

5. Which program under Windows 3.1 allows you to easily work with files?
   a. Program Manager
   b. File Manager
   c. Write
   d. Control Panel

6. Which phase means to make a group "window" or "icon" active?
   a. Select a group window
   b. Open a dialog box
   c. Write
   d. Control panel

7. Using Windows 95, the first step to open a program is:
   a. Move mouse to start icon
   b. Move mouse up to programs
   c. Move mouse up to documents
   d. Move mouse to settings

8. Using Windows 95, the second step to open a program is:
   a. Move mouse to start icon
   b. Move mouse up to programs
   c. Move mouse up to documents
   d. Move mouse to settings

9. Using Windows 95, if one wanted to add a printer, the first step would be to:
   a. Move mouse to start icon
   b. Move mouse up to programs
   c. Move mouse up to documents
   d. Move mouse to my computer

10. Using DOS, the command to create a directory is:
   a. MD (enter)
   b. CD (enter)
   c. CD (enter)
   d. RD (enter)

11. Using DOS, the command to remove a directory is:
   a. MD (enter)
   b. CD (enter)
   c. CD (enter)
   d. RD (enter)

12. The function key on a keyboard are located:
   a. Top horizontal
   b. Bottom horizontal
   c. Left section
   d. Right section

13. The numeric key pad is located:
   a. Top horizontal
   b. Bottom horizontal
   c. Left section
   d. Right section

14. This is a major hardware part of a personal computer.
    a. Paintbrush
    b. Write
    c. Monitor
    d. Program manager

15. The following is a computer language:
    a. BASIC
    b. Program manager
    c. File manager
    d. RAM

INT-F9
Understand Personal Computers
Self-Assessment Answer Key

1. A
2. C
3. D
4. A
5. B
6. A
7. A
8. B
9. D
10. A
11. D
12. A
13. D
14. C
15. A

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-F10

Subject: **Instrumentation** **Time: 60 Hrs.**

Duty: **Participate in Continuing Education Activities**
Task: Attend On-Going Safety Training Courses

Objective(s):

Upon completion of this module the student will be able to:

a. Identify safety equipment appropriate to protect the eyes from flying particulate matter or chemicals;
b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
c. Identify equipment appropriate to protect against high level of noise;
d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials;
e. Identify safety equipment appropriate to protect the lungs from chemicals or particles;
f. Identify the two major factors in working safely;
g. List four steps you can take prior to performing work that will insure a safe outcome;
h. Identify the employees responsibility if a potential accident or unsafe condition exist;
i. Select specific task that have the potential to cause an injury;
j. Describe typical safety equipment used when working aloft;
k. Describe how to set up a portable ladder for use;
l. Define basic safety concerns while working from scaffolding;
m Identify the safety concerns to be addressed while working from a personal man basket;
n. Demonstrate use of a safety belt/harness;
o. Demonstrate proper set up and use of a portable ladder;
p. Identify the technicians responsibility relative to fire safety;
q. List condition required for fire to exist;
r. Name four classes of fires;
s. List four typical causes of industrial fires described in the lesson;
t. Match the correct class extinguishers to a given fuel source;
u. Demonstrate proper use of a fire extinguisher;
v. Identify the consequences of improper lifting techniques;
w. Recognize when it is unsafe to lift an object alone;
x. Demonstrate proper lifting techniques;

y. Identify safety concerns to be addressed when lifting rough, sharp or fragile items;
z. Recognize the benefits of an effective lockout/tagout procedure;
aa. Identify who is allowed to remove or install a lockout/tagout or lock;
ab. Recognize who is responsible for assuring equipment is properly locked out or tagged out prior to performing maintenance; and,
ac. Determine if all emergency conditions are cleared for maintenance.

Instructional Materials:

Overhead projector
Gloves
Safety goggles
Dust mask
Hearing protection (ear plugs and ear muffs)
Face shields
Handout reading assignments
Safety belt
Side shields
Large empty cardboard box
Pencil
Paper
Hand truck
Conveyor
Chains
Sling
Lock (designed for lockout)
Safety tags
Lockout hasp
Safety switch
Relief valve
Hydraulic actuated valve
Safety sign (CAUTION-lockout for safety before you start)
Valve lockout
Multimeter
Electrical gloves
Chalk board
Resistors
Electrical hand tools
Wood ladder
GFCI
MASTER Handout (INT-F10-HO)
MASTER Laboratory Aid (INT-F10-LA)
MASTER Laboratory Worksheet (INT-F10-LW)

References:

Complete Text of OSHA Guidelines- 29 CFR 1910

First Aid Textbook, American National Red Cross, 17th and D Sts. NW., Washington DC 20006, Latest Edition

Approval Guide; Handbook of Property Conservation; and ***Loss Prevention Data,*** Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston - Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Dubuque, IA, Kendall/Hunt Publishing Co., Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide); and ***Practice for Industrial Lighting (ANSI A11.1-1965),*** Illuminating Engineering Society, 345 East 47th St., New York NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety; and ***Loss Control,*** International Labor Organization, 666 11th St. NW., Washington, DC 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI CI-1971); National Fire Codes (10 Volumes); and, ***Standards and Recommended Practices,*** National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

Air Purifying Respirators - 30m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Personal Protection - 20m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Using Respirators In Hazardous Environments - 30m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Four Elements of Respiratory - 11m - Video Tape, Latest Edition

Safety, Environmental Affairs Journal - 33:08m - Video Tape - Coastal Video Communication, 3083 Brickhouse Court, Virginia Beach, VA 23452, Latest Edition

Protective Clothing - 6:13m - Video Tape, Latest Edition

Hearing Protection Training, 1100 Series Ear Plugs - 2m - Video Tape, Latest Edition

Lifting, Eye Protection and Hand Tool Safety - 20m - Video Tape - BBP, Latest Edition

Advanced Ind. Head Protection - 20m - Video Tape - E.D. Bellard Co., Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

INT-F9 "Understand Personal Computers"

Introduction:

Safety is first for the individual and industrial plants. Not to mention, good safety records yield lower insurance rates!

Presentation Outline:

I. Describe Types of Conditions That Would Require the Use of Protective Equipment Due to Air Borne Partials
   - A. Grinding operations
   - B. Any time while in an active production environment
   - C. Near welding operations
   - D. Near high pressure water, air, or other medians i.e., oil
   - E. Possibility of splashing chemicals

II. Identify Condition That Would Require the Use of a Hard Hat
   - A. Generally anytime while in a construction or manufacturing environment
   - B. In areas with low overhead clearances

III. Review Conditions That Would Require Use of Hearing Protection
- A. Ear plugs
- B. Ear muffs
- C. OSHA requirements

IV. Describe Typical Conditions That Would Warrant Use of Gloves to Protect the Hands
- A. Grinding
- B. Working with rough metals
- C. Working with multi strand steal cables
- D. Electrical (Special insulated gloves may be required for certain voltages)

V. Identify How Lungs Are Protected from Harmful Chemicals/Particles
- A. Plant engineering/ventilation
- B. Use of respirators or bubble suits
- C. Review OSHA requirements for fiber glass, asbestos and chemical protection

VI. Major Factors in Working Safely
- A. Knowing what records are required
  1. Recognizing when things are not as they should be
- B. Attitude towards safety
  1. A state of mind that requires you to accept responsibility for you and your coworkers safety
  2. A state of mind that does not compromise safety for production or speed
  3. A state of mind that would stop production rather than put an employee at unnecessary risk

VII. Four Steps That Help Insure a Safe Job
- A. Preparing to do the job
  1. Research task to insure it can be performed
  2. Appropriate tools and help are available
  3. Proper lockout procedure
- B. Select appropriate safety equipment
- C. Once the job starts, maintain a clean work place
- D. Avoid unsafe practices
  1. Failing to use safety equipment
  2. Performing task you are not qualified to perform
  3. Rushing
  4. Practical joking
  5. Making do with a tool rather than getting the right tool

VIII. Employee Responsibility
- A. Assure responsibility for your own safety
- B. Notify crew and supervision of an unsafe condition occurs
- C. Stop work if unsafe condition is identified

IX. Tasks That Have the Potential to Cause Injury
- A. Working with electricity

B. Working near rotating equipment
C. Working with chemicals and solvents
D. Using pneumatic or hydraulic equipment
E. Using ladders
F. Lifting heavy objects
G. Working in areas with harmful fumes

X. Identify Safety Equipment Used When Working Aloft

Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA

A. Equipment common to most personnel when working aloft
   1. Safety glasses
   2. Hard hat
   3. Safety belt or harness

XI. Describe How to Set up a Portable Ladder for Use

A. Portable ladder are broken down in the CFRs as metal and wood ladders
B. Wood ladders see 29CFR-1910.25
   1. Single section ladder
   2. Two section ladder
   3. Special use wood ladders
   4. Step ladder
C. Metal ladders see 29CFR-1910.26
D. Set up 29 CFR-1910.26
   1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall for all sectional ladders

XII. Basic Safety Concerns While Working from Scaffolding

Note: This module does not address scaffolding erection because special training is required

A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
C. Never lean over the handrails to perform work

XIII. Concerns While Working from a Manlift or Personnel Fit (see 29 CFR-1910.68)

A. Use basket or lift for employees and tools only not freight
B. If basket has integral test weights insure weights are removed prior to lifting personnel
C. Hands must be inside basket while basket is moving
D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
E. Always inspect basket rigging prior to entry
F. Once the basket is in position it must be tied off if egress from the basket is required

XIV. Demonstrate Proper Set up and Use of an Extension Ladder
- A. Determine wall to base of ladder distance
- B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

XV. Technician's Responsibility
- A. Each employer will have company specific rules
- B. Unless the technician is part of the company fire fighting crew or fire brigade
  1. Notify every one in the area to evacuate
  2. Get to a phone and notify appropriate department
  3. Something as simple as an ash tray or trash can, can start fire that may be easily and safely extinguished. Appropriate department must be notified of the event
  4. Employees are responsible for keeping the workplace safe and for reporting unsafe conditions

XVI. Identify Conditions Required for a Fire to Exist
- A. Fuel
- B. Oxygen
- C. Heat

XVII. Four Classes of Fire
- A. Ordinary combustibles
- B. Flammable liquids
- C. Electrical
- D. Combustible metals

XVIII. List Four Typical Causes of Workplace Fires
- A. Careless smokers
- B. Electrical overloads
- C. Inadequate fire watch for welding and cutting operations
- D. Combustible dust in the atmosphere

XIX. Demonstrate How to Match the Correct Extinguishers for the Class of Fire

XX. Demonstrate Proper Use of a Fire Extinguisher

XXI. Discuss the Importance of Lifting Safely
- A. Give each student a copy of the following attachments
  1. Laboratory aid
  2. Objectives, reading assignments, and module outline
  3. Laboratory worksheet

XXII. Identify the Steps to Manually Lift Safely
- A. Estimate the load to be lifted. If it is heavier than one person should attempt, get help
- B. Place feet properly. Spread your feet slightly (comfortably), with one foot slightly ahead of the other and alongside the object
- C. Bend knees, kneel, or squat. Get close enough to the load to reach under it without bending the back

D. Use blocking under objects to get a handhold and to prevent crushed fingers
E. Get a good grip. Be sure you can maintain your grip on the object. Use gloves when handling sharp or rough objects
F. Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting
G. Do not turn the body at the waist while carrying a load
H. Lower the load to the floor from the carrying position by bending the knees while keeping the back straight. This keeps the load on the leg and arm muscles. Keep fingers and toes clear as the load is set

XXIII. Discuss Equipment for Material Handling
A. Hand Trucks
B. Powered Trucks
C. Conveyers

XXIV. Discuss and Demonstrate Safe Use of Hand Trucks
A. Place most of the weight on bed of hand truck
B. May require two people id object is difficult to lift on our side
C. Hold object tightly as handled is pulled back
D. Adjust handle position so more weight is on hand end
E. After movement, hold object tightly as handle is moved upward
F. Lift object on one side so bed of truck can be moved away from object

XXV. Discuss and Demonstrate Use of Powered Hand Trucks
A. Watch out for people
B. Use caution drive unit slowly
C. Use manual lifting rules

XXVI. Discuss and Demonstrate Safe Use of Conveyers
A. Watch for pinch points
B. Exercise caution when loading and unloading objects
C. Do not overload conveyers. Rollers may not move freely

XXVII. Discuss and Demonstrate Safe Use of Chains and Slings
A. Storage area should be clean and dry
B. Watch for pinch points
C. Inspect for defects before using:
    1. Chains
        a. Wear
        b. Stretch
        c. Distortion
        d. Nicks
        e. Cracks
        f. Gauges
    2. Slings
        a. Wear
        b. Stretch

c. Distortion
d. Flat, Sling Spots

D. Types
1. Slings
a. Choker
b. Double Choker
c. Bridle
d. Basket
e. Double Basket

XXVIII. Benefits of an Effective Lockout/Tagout Program
A. Reduce employee injuries and death
B. Reduce down time
C. Increased awareness of employees role in insuring safety in the work environment
D. Less regulatory involvement
E. Review 29 CFR-1910.147

XXIX. Who May Hang, Remove a Lockout or Tagout Tag or Lock
A. Identify when a lockout is needed
B. Identify when a tagout is appropriate. This will vary between industry clearance procedures

XXX. Responsibility for Lockout/Tagout
A. Typically it is the work crew leader
1. He/she is also responsible for briefing the crew as to the clearance boundaries and what is locked out
B. Carefully loosen a flange and break the seal (Never remove the bolts). Only loosen slightly
C. Open system relief valve

XXXI. Locking out or Clearing a Piping, Mechanical System or Component for Maintenance
A. Identify typical sources of force that may be present in a typical piping system
1. Static head pressure/thermal induced pressure
2. Incline accumulators
3. Unisolated automatic actuating valves, motors or relief
4. System pressure
5. Stress that any or all of these forces have the ability to injure or kill is not properly cleared lockout and depressurized prior to maintenance
B. Methods of relieving trapped pressure from a system or component
1. Vent and drain valves
2. Carefully loosen a flange and break the seal (*never* remove the bolts); only loosen slightly
3. Open system relief valve

C. Identify typical methods of disabling components prior to maintenance
    1. Manual operated valves
    2. Pneumatic operated valves (fail open or closed)
    3. Hydraulic actuated valve
    4. Relief valves
    5. Fans
    6. Rollers
D. Energy sources can take many forms, including:
    1. Electrical
    2. Pneumatic
    3. Hydraulic
    4. Mechanical
    5. Fluid and gases
    6. Thermal
    7. Water under pressure
    8. Gravity
E. Accidental start-up and/or release of stored energy can sometimes be controlled with safety devices. Some examples are:
    1. Machine guards
    2. Electrical disconnects
    3. Mechanical stops
    4. Point-of-operation guards

XXXII. Electric Shock
- A. Voltage Level
- B. Current Level
- C. One Hand Rule

XXXIII. Electrical Resistance
- A. Body Resistance
- B. Current Path
- C. Ohm's Low

XXXIV. Electrical Test Meters
- A. Ohmmeter
- B. Voltmeter
- C. Ammeter

XXXV. Tools
- A. Ladders
- B. Electrical Hand Tools
- C. Tool Condition

XXXVI. Protective Equipment
- A. Multimeter
- B. Electrical Gloves
- C. Electrical Hand Tools

XXXVII. Ground Fault Circuit Interrupter (GFCI)
- A. NEC Requirements

B. How GFCI Works
C. GFCI Format

XXXVIII. Two Man Rule
A. Buddy System
B. Second Person's Responsibility

XXXIV. Guarding
A. Safe distance from live circuits
B. NEC 110-10, 240-41, 430-14, 511-7, 513-5, 514-4, 515-4, 516-7, 517
C. 29 CFR 1910.331 through 29 CFR 1910.335

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-F11) dealing with participating in plant related training.

INT-F10-HO
Attend On-Going Safety Training Courses
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify safety equipment appropriate to protect the eyes from flying particulate matter or chemicals;
b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
c. Identify equipment appropriate to protect against high level of noise;
d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials;
e. Identify safety equipment appropriate to protect the lungs from chemicals or particles;
f. Identify the two major factors in working safely;
g. List four steps you can take prior to performing work that will insure a safe outcome;
h. Identify the employees responsibility if a potential accident or unsafe condition exist;
i. Select specific task that have the potential to cause an injury;
j. Describe typical safety equipment used when working aloft;
k. Describe how to set up a portable ladder for use;
l. Define basic safety concerns while working from scaffolding;
m Identify the safety concerns to be addressed while working from a personal man basket;
n. Demonstrate use of a safety belt/harness;
o. Demonstrate proper set up and use of a portable ladder;
p. Identify the technicians responsibility relative to fire safety;
q. List condition required for fire to exist;
r. Name four classes of fires;

s. List four typical causes of industrial fires described in the lesson;
t. Match the correct class extinguishers to a given fuel source;
u. Demonstrate proper use of a fire extinguisher;
v. Identify the consequences of improper lifting techniques;
w. Recognize when it is unsafe to lift an object alone;
x. Demonstrate proper lifting techniques;
y. Identify safety concerns to be addressed when lifting rough, sharp or fragile items;
z. Recognize the benefits of an effective lockout/tagout procedure;
aa. Identify who is allowed to remove or install a lockout/tagout or lock;
ab. Recognize who is responsible for assuring equipment is properly locked out or tagged out prior to performing maintenance; and,
ac. Determine if all emergency conditions are cleared for maintenance.

Reading Assignments:

The following chapters are assigned to read from *Supervisor's Safety Manual* textbook, Latest Edition:

Chapter	Title
7	Controlling Hazards; Protecting the Eyes: Equipment Types, Face Protection, Overcoming Employee Complaints; Protecting the Head: Fabrication, Auxiliary Features, Overcoming Objections; Ear Protection: Amount of Protection, Insert-Type Protectors, Muff Types; Protecting Fingers, Palms, and Hands; Protecting the Torso; Respiratory Protective Equipment: Selecting the Respirator, Overcoming Employee Complaints; Safety Belts and Harnesses: Fabrication, Lifelines, Inspection and Care of Belts and Lines; Protection Against Ionizing Radiation: Monitoring Radiation; Safe Work Clothing: Materials for Protective Clothing; Clothing for Women, Special Problems Today for Men; "Selling" Personal Protective Equipment: Paying for Protective Equipment.
4	Promote Safe Workmanship: Employee Committees, Safety Posters, Special-Purpose Reminders, Off-Beat Ideas, Recognition Organizations, Safety Meetings; Off-the-Job Accident Problems: Cost of Off-the-Job Accident Problems: Cost of Off-the-Job Accidents, Humanitarian Reasons for OTJ Safety Activities, Measuring Accident Experience, Integrating OTJ with On-the-Job Safety Programs, the Supervisor's Role in OTJ Safety.

5	Giving Instructions: Importance of Job Instruction, Starting the New Man; On-the-Job Training: Over-the-Shoulder Coaching; Job Safety Analysis: Select the Job, Break the Job Down, Identify Hazards and Potential Accidents, Develop Solutions, Benefits of JSA; Job Instruction Training: Step 1-Preparations, Step 2-Presentation, Step 3-Application, Step 4-Testing Follow-up; Other Methods of Instruction: The Lesson Plan, Programmed Instruction, Independent Study, Closed-Circuit TV, Summary.
9	Material Handling Problems; Manual Handling Methods; Lifting and Carrying; Handling Specific Shapes; Equipment for Handling; Hand Trucks; Powered Hand Trucks; Powered Industrial Trucks; Conveyors; Chains and Slings
12	Basic Principles; Understanding Fire Chemistry; Determining Fire Hazards; Informing the Working Force; Causes of Fire: Electric Equipment, Friction; Special Fire-Hazard Materials; Welding and Cutting; Open Flames; Portable Heaters; Hot Surfaces; Smoking and Matches; Spontaneous Ignition; Static Electricity; Fire-Safe Housekeeping; Alarms; Equipment; Evacuation; Fire Alarms; What About Extinguishers?; Follow Up for Fire Safety; Fire Brigades; Special Fire Protection Problems

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Module Outline:

I. Describe Types of Conditions That Would Require the Use of Protective Equipment Due to Air Borne Partials
   - A. Grinding operations
   - B. Any time while in an active production environment
   - C. Near welding operations
   - D. Near high pressure water, air, or other medians i.e., oil
   - E. Possibility of splashing chemicals

II. Identify Condition That Would Require the Use of a Hard Hat
   - A. Generally anytime while in a construction or manufacturing environment
   - B. In areas with low overhead clearances

III. Review Conditions That Would Require Use of Hearing Protection
   - A. Ear plugs
   - B. Ear muffs
   - C. OSHA requirements

IV. Describe Typical Conditions That Would Warrant Use of Gloves to Protect the Hands
   - A. Grinding
   - B. Working with rough metals

C. Working with multi strand steal cables
D. Electrical (Special insulated gloves may be required for certain voltages)

V. Identify How Lungs Are Protected from Harmful Chemicals/Particles
A. Plant engineering/ventilation
B. Use of respirators or bubble suits
C. Review OSHA requirements for fiber glass, asbestos and chemical protection

VI. Major Factors in Working Safely
A. Knowing what records are required
1. Recognizing when things are not as they should be
B. Attitude towards safety
1. A state of mind that requires you to accept responsibility for you and your coworkers safety
2. A state of mind that does not compromise safety for production or speed
3. A state of mind that would stop production rather than put an employee at unnecessary risk

VII. Four Steps That Help Insure a Safe Job
A. Preparing to do the job
1. Research task to insure it can be performed
2. Appropriate tools and help are available
3. Proper lockout procedure
B. Select appropriate safety equipment
C. Once the job starts, maintain a clean work place
D. Avoid unsafe practices
1. Failing to use safety equipment
2. Performing task you are not qualified to perform
3. Rushing
4. Practical joking
5. Making do with a tool rather than getting the right tool

VIII. Employee Responsibility
A. Assure responsibility for your own safety
B. Notify crew and supervision of an unsafe condition occurs
C. Stop work if unsafe condition is identified

IX. Tasks That Have the Potential to Cause Injury
A. Working with electricity
B. Working near rotating equipment
C. Working with chemicals and solvents
D. Using pneumatic or hydraulic equipment
E. Using ladders
F. Lifting heavy objects
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Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA

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A. Portable ladder are broken down in the CFRs as metal and wood ladders

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   1. Single section ladder
   2. Two section ladder
   3. Special use wood ladders
   4. Step ladder

C. Metal ladders see 29 CFR-1910.26

D. Set up 29 CFR-1910.26
   1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall for all sectional ladders

XII. Basic Safety Concerns While Working from Scaffolding

Note: This module does not address scaffolding erection because special training is required

A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire

B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness

C. Never lean over the handrails to perform work

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E. Always inspect basket rigging prior to entry

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A. Determine wall to base of ladder distance

B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

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A. Each employer will have company specific rules

B. Unless the technician is part of the company fire fighting crew or fire brigade
   1. Notify every one in the area to evacuate
   2. Get to a phone and notify appropriate department
   3. Something as simple as an ash tray or trash can, can start fire that may be easily and safely extinguished. Appropriate department must be notified of the event
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- B. Oxygen
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- B. Flammable liquids
- C. Electrical
- D. Combustible metals

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- A. Careless smokers
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- C. Inadequate fire watch for welding and cutting operations
- D. Combustible dust in the atmosphere

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XX. Demonstrate Proper Use of a Fire Extinguisher

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- A. Give each student a copy of the following attachments
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   2. Objectives, reading assignments, and module outline
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- D. Use blocking under objects to get a handhold and to prevent crushed fingers
- E. Get a good grip. Be sure you can maintain your grip on the object. Use gloves when handling sharp or rough objects
- F. Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting
- G. Do not turn the body at the waist while carrying a load

H. Lower the load to the floor from the carrying position by bending the knees while keeping the back straight. This keeps the load on the leg and arm muscles. Keep fingers and toes clear as the load is set

XXIII. Discuss Equipment for Material Handling

A. Hand Trucks
B. Powered Trucks
C. Conveyers

XXIV. Discuss and Demonstrate Safe Use of Hand Trucks

A. Place most of the weight on bed of hand truck
B. May require two people id object is difficult to lift on our side
C. Hold object tightly as handled is pulled back
D. Adjust handle position so more weight is on hand end
E. After movement, hold object tightly as handle is moved upward
F. Lift object on one side so bed of truck can be moved away from object

XXV. Discuss and Demonstrate Use of Powered Hand Trucks

A. Watch out for people
B. Use caution drive unit slowly
C. Use manual lifting rules

XXVI. Discuss and Demonstrate Safe Use of Conveyers

A. Watch for pinch points
B. Exercise caution when loading and unloading objects
C. Do not overload conveyers. Rollers may not move freely

XXVII. Discuss and Demonstrate Safe Use of Chains and Slings

A. Storage area should be clean and dry
B. Watch for pinch points
C. Inspect for defects before using:
    1. Chains
        a. Wear
        b. Stretch
        c. Distortion
        d. Nicks
        e. Cracks
        f. Gauges
    2. Slings
        a. Wear
        b. Stretch
        c. Distortion
        d. Flat, Sling Spots
D. Types
    1. Slings
        a. Choker
        b. Double Choker
        c. Bridle

d. Basket
e. Double Basket

XXVIII. Benefits of an Effective Lockout/Tagout Program
- A. Reduce employee injuries and death
- B. Reduce down time
- C. Increased awareness of employees role in insuring safety in the work environment
- D. Less regulatory involvement
- E. Review 29 CFR-1910.147

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- A. Identify when a lockout is needed
- B. Identify when a tagout is appropriate. This will vary between industry clearance procedures

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- A. Typically it is the work crew leader
  1. He/she is also responsible for briefing the crew as to the clearance boundaries and what is locked out
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- C. Open system relief valve

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- A. Identify typical sources of force that may be present in a typical piping system
  1. Static head pressure/thermal induced pressure
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  3. Unisolated automatic actuating valves, motors or relief
  4. System pressure
  5. Stress that any or all of these forces have the ability to injure or kill is not properly cleared lockout and depressurized prior to maintenance
- B. Methods of relieving trapped pressure from a system or component
  1. Vent and drain valves
  2. Carefully loosen a flange and break the seal (*never* remove the bolts); only loosen slightly
  3. Open system relief valve
- C. Identify typical methods of disabling components prior to maintenance
  1. Manual operated valves
  2. Pneumatic operated valves (fail open or closed)
  3. Hydraulic actuated valve
  4. Relief valves
  5. Fans
  6. Rollers

D. Energy sources can take many forms, including:
   1. Electrical
   2. Pneumatic
   3. Hydraulic
   4. Mechanical
   5. Fluid and gases
   6. Thermal
   7. Water under pressure
   8. Gravity

E. Accidental start-up and/or release of stored energy can sometimes be controlled with safety devices. Some examples are:
   1. Machine guards
   2. Electrical disconnects
   3. Mechanical stops
   4. Point-of-operation guards

XXXII. Electric Shock
   A. Voltage Level
   B. Current Level
   C. One Hand Rule

XXXIII. Electrical Resistance
   A. Body Resistance
   B. Current Path
   C. Ohm's Low

XXXIV. Electrical Test Meters
   A. Ohmmeter
   B. Voltmeter
   C. Ammeter

XXXV. Tools
   A. Ladders
   B. Electrical Hand Tools
   C. Tool Condition

XXXVI. Protective Equipment
   A. Multimeter
   B. Electrical Gloves
   C. Electrical Hand Tools

XXXVII. Ground Fault Circuit Interrupter (GFCI)
   A. NEC Requirements
   B. How GFCI Works
   C. GFCI Format

XXXVIII. Two Man Rule
   A. Buddy System
   B. Second Person's Responsibility

XXXIV. Guarding
   A. Safe distance from live circuits

B. NEC 110-10, 240-41, 430-14, 511-7, 513-5, 514-4, 515-4, 516-7, 517

C. 29 CFR 1910.331 through 29 CFR 1910.335

Standards of performance safety:

Student shall demonstrate safety knowledge when working in the shop by:
Observing all safety rules in lab;
Not touching an energized electrical circuit;
Exercising extreme caution in dealing with an electrical circuit;
Using electrically tested gloves and properly using calibrated test equipment when working with electricity;
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-F10-LW
Attend On-Going Safety Training Courses
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Ear Plugs
   Ear Muffs

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercise inserting and removing ear plugs.

5. Practice using ear plugs.

6. Practice exercise using ear muffs.

Worksheet:

I. Identify safety equipment used when working aloft.
   Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA.
   - A. Equipment common to most personnel when working aloft:
     1. Safety glasses
     2. Hard hat
     3. Safety belt or harness

2. Describe how to set up a portable ladder for use.
   - A. Portable ladders are broken down in the CFRs as metal and wood ladders.
   - B. Wood ladders (see 29 CFR-1910.25)
     1. Single section ladder
     2. Two section ladder
     3. Special use wood ladders
     4. Step ladder
   - C. Metal ladders (see 29 CFR-1910.26)
   - D. Set up 29 CFR-1910.26
     1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall.

3. Basic safety concerns while working from scaffolding.
   Note: This module does not address scaffolding erection because special training is required.
   - A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire.
   - B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness.
   - C. Never lean over the handrails to perform work.

4. Concerns while working from a manbasket or personnel fit.
   - A. Use basket or lift for employees and tools only not freight
   - B. If basket has integral test weights insure weights are removed prior to lifting personnel.
   - C. Hands must be inside basket while basket is moving.
   - D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline.
   - E. Always inspect basket rigging prior to entry.
   - F. Once the basket is in position it must be tied off if egress from the basket is required.

5. Demonstrate proper set up and use of an extension ladder.
   A. Determine wall to base of ladder distance.
   B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder.

Worksheet:

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Hand truck
   Conveyor
   Chains
   Sling
   Face shield
   Side shields

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercise manual lifting.

5. Practice using hand truck to carry objects.

6. Practice using powered truck to carry objects.

7. Practice exercise handling specific shapes.

8. Practice lifting with slings.

9. Practice lifting with chains.

10. Instructor will guide each exercise.

11. Instructor will grade each exercise.

Worksheet:

The project will require the student to demonstrate skills and knowledge in the following.

a. Practice safety
b. Use approved eye protection.
c. Remove energy source
d. Place tag
e. Place lock
f. Sign tag
g. Remove lock
h. Remove tag

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Lock
   Tag
   Safety Switch

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercises:
   A. Use lock to lock energy supply.
      (Instructor must demonstrate placing lock on energy supply.)
   B. Use tag to tag energy supply.
      (Instructor must demonstrate placing tag on energy supply.)

5. Practice exercise :
   1. Student shall practice placing tag on energy source.
   2. Student shall practice placing lock on energy source.

Name:_____ Date:_____

INT-F10
Attend On-Going Safety Training Courses
Self-Assessment

1. What should not be worn around rotating or other movable parts machinery?
_____
_____
_____

2. Name two types of devices which provide protection to the eye.
_____
_____
_____

3. There are three types of coverings that provide protection from objects striking the head. Name the two of them.
_____
_____
_____

4. How do you determine if a pair of glasses are safety glasses?
_____
_____
_____

5. Of the two types of ear protection, which generally gives the best protection?
_____
_____
_____

6. What type of safety devices and apparel should be worn when you use solvents to clean parts or surfaces?
_____
_____
_____

7. List all types of hearing protection.
_____
_____
_____

8. What is purpose of eyewash equipment?

9. What is FDA's

10. List two major factors in working safely.

11. Safety is _____ responsibility.

12. One of the most important factors in personal safety is _____.

13. A ladder with a 250 lb. Weight capacity for heavy duty use is considered:
    a. Type IA
    b. Type I
    c. Type II
    d. Type III

14. An aluminum ladder can be used near electrical sources if it has rubber feet on the bottom.
    a. True
    b. False

15. How far must a ladder extend beyond the roof line if you are going to climb onto the structure.
    a. 1 foot
    b. 3 feet
    c. 10 feet
    d. None of the above

16. The base of a ladder should be placed so that it is one foot away from the structure for every four feet of height to the point where the ladder rests against the building?
    a. True
    b. False

17. A ladder whose top support point is 12 feet high should be how far from the structure?
    a. 2 feet
    b. 3 feet
    c. 4 feet
    d. None of the above

18. A step ladder can be leaned against a structure if it is secured at the bottom.
    a. True
    b. False

19. How often should a ladder be inspected?
    a. Once a month by maintenance personnel only
    b. Only if it has been dropped
    c. Before each use
    d. One of the above

20. Conditions required for a fire to exist:
    a. Fuel, hydrogen heat
    b. Hydrogen, oxygen, fuel
    c. Heat, hydrogen, oxygen
    d. Fuel, oxygen, heat

21. Four classes of fire are:

    _____
    _____
    _____
    _____

22. List four typical causes of workplace fires:

    _____
    _____
    _____
    _____

23. A class _____ fire extinguisher is used for electrical fires.

24. A class _____ fire extinguisher is used for ordering combustibles fires.

25. The term lockout is best defined as:
    a. Blocking the flow of energy from a power source to a piece of equipment.
    b. Shutting down a piece of equipment for service or maintenance work.
    c. Applying a lock to a piece of equipment to show that is should not be used.
    d. Applying a tag to a piece of equipment to show that it should not be used.

26. A lockout procedure is used whenever:
    a. The servicing or repair work to be done places an employee in danger.
    b. An equipment guard must be removed for servicing.
    c. A power source can be locked out for servicing.
    d. All of the above.

27. Tagout refers to:
    a. The warning tag attached to a power source or piece of machinery telling others not to restart.
    b. The process of blocking energy form reaching a piece of equipment.
    c. Signing off that a certain piece of machinery has been serviced.
    d. A device that physically prevents others from restarting equipment.

28. An authorized employee is one who:
    a. Works on machinery that is subject to lockout.
    b. Services machinery that is subject to lockout.
    c. Actually locks out equipment for servicing.
    d. Both b and c.

29. An affected employee is one who:
    a. Works on machinery that is subject to lockout.
    b. Works in an area where lockout is used.
    c. Services machinery that is subject to lockout.
    d. Both a and b.

30. Zero energy state refers to:
    a. A power source that is locked out for servicing.
    b. A power source that is locked out and tagged for servicing.
    c. The release of all stored energy from a power source.
    d. The release of all locks and tags so that energy can be restored.

31. It is all right to lend your lock to a co-worker if:
    a. The co-worker's lock is in another part of the building.
    b. The co-worker's lock is in another building miles away form where he is working.
    c. You know you won't be using your lock.
    d. None of the above.

32. If you come across a piece of equipment that is turned off but not locked out, you would:
    a. Ask someone working in the area if it could be turned back on.
    b. Notify someone who is authorized to perform lockout.
    c. Never restart the equipment.
    d. Both b and c.

33. A lockout audit must be performed by:
    a. An authorized person who works with the lockout procedure to be inspected.
    b. An authorized person who doesn't work with the lockout procedure to be inspected.
    c. A person from the health and safety department.
    d. None of the above.

34. Lockout/Tagout procedures are in place to:
    a. Prevent the accident start-up of equipment.
    b. Prevent workers from taking short-cuts while servicing equipment.
    c. To be used when startup occurs.
    d. To be used when the machine is stopped.

35. The _____ physically prohibits the operation of a piece of equipment.
    a. GFCI
    b. Tagout device
    c. Lockout device
    d. a, b, and c

36. The _____ does not physically prohibit operation of equipment; it relies on those who relies on those who read it.
    a. GFCI
    b. Tagout device
    c. Lockout device
    d. a, b, and c

37. Zero energy means all forms of energy (electrical, mechanical, fluid, and thermal) are neutralized.
    a. True
    b. False

38. Under normal operating conditions, in addition to you, who is allowed to remove your padlock form a machine's power source after a power lockout?
    a. No one
    b. The maintenance supervisor
    c. The safety engineer
    d. Your supervisor

39. This organization establishes, implements, and enforces safe workplace guidelines.
    a. NEC
    b. ANSI
    c. OSHA
    d. NEMA
    e. UL
    f. UAW

40. A/an _____ is sensitive to very low levels of current leakage to ground.
    a. Ground-fault interrupter
    b. Magnetic breaker
    c. Thermal breaker
    d. Adjustable inductor

41. A ground fault outlet is designed to trip at:
    a. An overload of 16 to 21 amps
    b. Any fault current
    c. Any over current
    d. A fault current from 4 milliamps to 6 milliamps

42. **Painful shock begins at 8 mA and muscle control is list at 15 mA.** For a person with dry, uninjured skin, body resistance may be 8,000 ohms. If current enters through one hand and leaves through the other hand at 120 volts, using Ohms law, indicate below if not muscle control will be lost.
    a. Yes! Current is 15 mA
    b. Yes! Current exceeds 20 mA
    c. No! Current is 10 mA
    d. No! Current is 6mA

43. Before checking for a shorted or grounded circuits, one should:
    a. Turn off all power to unit
    b. Replace all fuses
    c. Connect the ohmmeter in series with the load
    d. All the above

44. If it is necessary to test a "live" electrical circuit, you would:
    a. Use only one hand
    b. Turn power off to connect test leads if possible
    c. Test your meter on a known source of power
    d. a., b., and c.
    e. b. and c. only

Attend

1. Loose clothing
2. Safety goggles and
3. Hard hat and bum
4. Look at marking o
5. Ear muffs
6. Gloves
7. Ear muffs, eye plu
8. Dilute acid in eye
9. Food and Drug Ad
10. Attitude and awar
11. Everyone's
12. Attitude
13. b
14. b
15. b
16. a
17. b
18. a
19. c
20. b
21. A, B, C, and D

22. Combustibles, flammable liquids, electrical equipment, and combustible metals

23. c

24. a

25. b

26. d

27. a

28. d

29. b

30. c

31. d

32. d

33. a

34. a

35. c

36. b

37. a

38. a

39. c

40. a

41. d

42. a

43. a

44. e

INT-F11

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-F11

Subject: Instrumentation Time: 40 Hrs.

Duty: Participate in Continuing Education Activities
Task: Participate in Plant Related Training

Objective(s):

Upon completion of this module the student will be able to:
a. Discuss why plant related training is important;
b. Compare team to group;
c. Define PPE; and,
d. Define SPC.

Instructional Materials:

MASTER Handout (INT-F11-HO)
MASTER Laboratory Aid (INT-F11-LA)
MASTER Self-Assessment

References:

Complete text of OSHA Guidelines, 29 CFR 1910

First Aid Textbook, American National Red Cross, 17th and D Sts. NW, Washington, DC 20006, Latest Edition

Approval Guide, Handbook of Property Conservation, and Loss Prevention Data, Factory Mutual Engineering Corporation of the Factory Mutual System, 1151 Boston – Providence Turnpike, Norwood, MA 02062, Latest Editions

Guide to Occupational Safety and Health Management, Firenze, Robert J., Dubuque, IA, Kendall/Hunt Publishing Co., Latest Edition

Supervisor's Guide to Human Relations, Hannaford, Earle S., Chicago, IL, National Safety Council, Latest Edition

IES Lighting Handbook (The Standard Lighting Guide); and ***Practice for Industrial Lighting (ANSI A11.1-1965)***, Illuminating Engineering Society, 345 East 47th St., New York NY 10017, Latest Editions

Encyclopedia of Occupational Health and Safety, and *Loss Control*, International Labor Organization, 666 11th St. NW., Washington, DC 20001, Latest Editions

A Safety Guidebook for Trades and Services, Van Nostrand Reinhold Co., New York, NY, Latest Edition

Fire Prevention Handbook; Fire Protection Guide on Hazardous Materials; Inspection Manual; National Electrical Code, Std. No. 70 (ANSI C1-1971); National Fire Codes (10 Volumes); and, *Standards and Recommended Practices*, National Fire Protection Association, 470 Atlantic Ave., Boston, MA 02210, Latest Editions

Air Purifying Respirators - 30m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Personal Protection - 20m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Using Respirators In Hazardous Environments - 30m - Video Tape - NUS Training Corp., 910 Clopper Rd., Gaithensbury, MD 20878, Latest Edition

Four Elements of Respiratory - 11m - Video Tape, Latest Edition

Safety, Environmental Affairs Journal - 33:08m - Video Tape - Coastal Video Communication, 3883 Brickhouse Court, Virginia Beach, VA 23452, Latest Edition

Protective Clothing - 8:03m - Video Tape, Latest Edition

Hearing Protection Training, 1100 Series Ear Plugs - 2m - Video Tape, Latest Edition

Lifting, Eye Protection and Hand Tool Safety - 29m - Video Tape - BBP, Latest Edition

Advanced Ind. Head Protection - 20m - Video Tape - E.D. Bellard Co., Latest Edition

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Student Preparation:

Students should have previously completed the following Technical Modules:

INT-F10 "Attend On-Going Safety Training Courses"

Introduction:

Plant specific is very important in order to operate efficiently as a team to produce a high quality, uniform product.

Presentation Outline:

I. Safety
II. Produce Familiarity
III. Team Building
IV. Quality
V. Plant Related Training

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-F12) dealing with attending PLC training.

INT-F11-HO
Participate in Plant Related Training
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;.
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Discuss why plant related training is important;
b. Compare team to group;
c. Define PPE; and,
d. Define SPC.

Module Outline:

I. Safety
II. Produce Familiarity
III. Team Building
IV. Quality
V. Plant Related Training

INT-F11-LA
Participate in Plant Related Training
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Name:_____ Date:_____

INT-F11
Participate in Plant Related Training
Self-Assessment

1. Compare Team to Group.

_____
_____
_____

2. Define PPE.

_____
_____
_____

3. Define SPC.

_____
_____
_____

4. Define Control Chart.

_____
_____
_____

5. Compare Lockout to Tagout

_____
_____
_____

INT-PTT

Participate in Plant Related Training

Self-Assessment Answer Key

1. Team works together as one unit. Group is a collection of people.

2. Personal protective equipment.

3. Statistical process control.

4. Used as a SPC tool of quality. A means of measurement.

5. Lockout physically locks in position. A tagout is a piece of paper with written information.

INT-F12

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-F12

Subject: Instrumentation **Time: 60 Hrs.**

Duty: Participate in Continuing Education Activities
Task: Attend PLC Training

Objective(s):

Upon completion of this module the student will be able to:

a. Identify major components of PLCs;
b. Program PLCs;
   1. Examine ON;
   2. Examine OFF;
   3. Output energize;
   4. Timers;
   5. Counter;
   6. Output latch;
   7. Master control relay;
   8. SFCs;
   9. Modes; and,
   10. PID.

Instructional Materials:

A.B. PLC 5/10 or other PLC
Vendor manuals
MASTER Handout (INT-F12-HO)
MASTER Laboratory Aid (INT-F12-LA)
MASTER Laboratory Worksheet (INT-F12-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-F11 "Participate in Plant Related Training"

Introduction:

PLCs are computer based, industrial, reprogramming machines. Their popularity is growing in industry. Programmable controllers are a ladder logic technique for programming. The flexibility of PLCs is phenomenal.

Presentation Outline:

I. Major Parts of PLC
II. Number Systems
III. Logic
IV. Inputs, Outputs
V. Timers
VI. Counter
VII. Master Control Relays
VIII. SFCs
IX. Modes
X. PID

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-F13) dealing with attending DCS training.

INT-F12-HO
Attend PLC Training
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify major components of PLCs;
b. Program PLCs;
   1. Examine ON;
   2. Examine OFF;
   3. Output energize;
   4. Timers;
   5. Counter;
   6. Output latch;
   7. Master control relay;
   8. SFCs;
   9. Modes; and,
   10. PID.

Reading Assignments:

Programmable Controllers And Design, Sequential Logic, Files, HBJ Publishing, Latest Edition:

Chapter	Title
1	Sequential Control
3	Relay Logic
4	Digital Logic
6	Programmable Controllers
7	Devices Used In Relay Logic
8	Processor Memory

9	Ladder Logic
10	Timer and Counter Instructions
14	Program Control Instructions
17	PLC Programming Languages

Module Outline:

I. Major Parts of PLC
II. Number Systems
III. Logic
IV. Inputs, Outputs
V. Timers
VI. Counter
VII. Master Control Relays
VIII. SFCs
IX. Modes
X. PID

INT-F12-LA
Attend PLC Training
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-F12-LW
Attend PLC Training
Attachment 3: **MASTER** Laboratory Worksheet

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1. Students will practice Programming a PLC:
    1. Major Parts of PLC;
    2. Number Systems;
    3. Logic;
    4. Inputs, Outputs;
    5. Timers;
    6. Counter;
    7. Master Control Relays;
    8. SFCs;
    9. Modes; and,
    10. PID.

2. Instructor will grade practical exercises.

Name:_____ Date:_____

INT-F12-HO
Attend PLC Training
Self-Assessment

1. Under normal operating conditions, the personal computer _____ to interface with the PLC.
   a. Is needed
   b. Will not be needed
   c. Is needed at all times
   d. Will only be needed

2. General start-up procedures include setting up the _____ and the _____ in the PLC and the personal computer.
   a. Computer, software
   b. CPU, memory
   c. Memory, I/O
   d. Hardware, software

3. A _____ is a device that installs in the serial port on the computer to enable the computer to run the PLC programming software.
   a. Hardware key
   b. EEPROM
   c. Control relay
   d. I/O group

4. Fill in the blank with ON if the description is of on-line programming. Fill in the blank with OFF if the description is of off-line programming.
   _____ a. Personal computer is not connected to the PLC.
   _____ b. Used to develop and test a ladder logic program.
   _____ c. Personal computer is connected to the PLC.
   _____ d. Allows debugging before running the program.
   _____ e. Used for final adjustments to program.
   _____ f. Requires strict safety precautions.

5. Match the following kinds of reports with their descriptions.

_____ a. ladder logic
_____ b. cross-reference listing
_____ c. status report
_____ d. histogram

1. Report of history of activity at a specified address
2. Report of status information at a given time
3. Report of any or all programmed logic
4. Report that tells where else in the ladder logic program an addressed item appears

6. The data table stores _____ information about the PLC.
   a. ASCII
   b. Status
   c. Program file
   d. Register

7. Besides the user memory, processor memory organization has a _____ area that holds the operating system for the PLC.
   a. Factory programmed memory
   b. EEPROM
   c. PROM
   d. RAM

8. The input image table stores status of all real world _____.
   a. Outputs
   b. Output modules
   c. Inputs
   d. Data files

9. The output image table stores status of all real world _____.
   a. Inputs
   b. Input modules
   c. Outputs
   d. Data files

10. Timer and counter storage stores _____, _____, and _____ data from timers and counters.
    a. Status, preset, accumulated
    b. Status, preset, discrete
    c. Status, accumulated, discrete
    d. Preset, accumulated, discrete

11. The PLC scan cycle continuously examines and updates _____.
    a. CPU, ROM, outputs
    b. CPU, RAM, outputs
    c. Inputs, ladder logic diagram, RAM
    d. Inputs, ladder logic program, outputs

12. A ladder logic diagram shows the logical sequence of _____ and _____ in a circuit.
    a. Inputs, data files
    b. Outputs, data files
    c. Inputs, Outputs
    d. Data files, nested branches

13. Ladder logic diagrams illustrate timers and counters with relay coils or _____.
    a. Function blocks
    b. Invertors
    c. Logic gates
    d. Discrete modules

14. A timer times out when the _____ equals the _____.
    a. Binary number, octal number
    b. Instruction, outputs
    c. Bit address, bit data file
    d. Accumulated value, preset value

15. An ON-DELAY (TON) timer _____ energizing its contact for a given time, or it measures the length of time an activity continues.
    a. Delays
    b. Starts
    c. Immediately
    d. Stops

16. Match the following words and definitions:

___ a. TON
___ b. RTO
___ c. Preset value
___ d. Accumulated value
___ e. Time base
___ f. Reset
___ g. Done bit

1. Amount of time timer is set to run
2. ON-DELAY timer
3. Retentive timer
4. Changes from zero to one when accumulated value equals preset value
5. Unit in which time is measured
6. Amount of time the timer has run
7. Accumulated time goes to zero

17. A retentive timer retains its _____ when power is interrupted.
a. Present value
b. Accumulated value
c. Starting value
d. Data file

18. A _____ can be used to keep track of the number of times a contact changes from open to closed.
a. Counter
b. Timer
c. Control relay
d. Done bit

19. Match the following terms and definitions.

____ a. CTU
____ b. CTD
____ c. Up/down counter
____ d. Preset value
____ e. Accumulated value
____ f. Done bit
____ g. Enabling contact
____ h. Reset

1. Counter that subtracts one from its count each time an event happens.
2. Number of times counter is set to count to.
3. Number of times counter has counted.
4. Trigger for counter function block.
5. Changes from zero to one when accumulated value equals preset value.
6. Counter that adds and subtracts events from the same register.
7. Counter that adds one to it count each time an event happens.
8. Accumulated value goes to zero.

20. Match the following terms and symbols:

____ a. =
____ b. not equal to symbol
____ c. >
____ d. equal to or greater than symbol
____ e. <
____ f. equal to or less than symbol

1. less than or equal to
2. not equal to
3. equal to
4. greater than
5. less than
6. greater than or equal to

21. The comparison function block uses the _____ label and specific symbol for the comparison to be made between the first register and the second register.

a. TON
b. JMP
c. MCR
d. CMP

22. When the MCR in the PLC is true, the rungs that follow it are _____. When the MCR in the PLC is false, the rungs that follow it are de-energized.
    a. De-energized
    b. True
    c. False
    d. Energized

23. MCR zones should not include _____ outputs that can cause invalid results that could lead to personal injury or equipment damage.
    a. Non retentive
    b. Retentive
    c. Unlatched
    d. Master control relay

24. Jump is the internal relay instruction for the PLC scan to _____ rungs that follow it.
    a. Skip
    b. Convert
    c. Invert
    d. Control

25. The jump instruction must be _____ for the PLC to jump the rungs.
    a. True
    b. False
    c. Off
    d. Delayed

26. The _____ contact with the same address as the JMP relay ends the jumped zone.
    a. Normally open
    b. Normally closed
    c. Time delay
    d. Label (LBL)

INT-F12
Attend PLC Training
Self-Assessment Answer Key

1. b

2. d

3. a

4. a. Off
   b. OFF
   c. On
   d. Off
   e. On
   f. On

5. a. 3
   b. 4
   c. 2
   d. 1

6. b

7. a

8. c

9. c

10. a

11. d

12. c

13. c

14. d

15. a

16. a. 2
b. 3
c. 1
d. 6
e. 5
f. 7
g. 4

17. b

18. a

19. a. 7
b. 1
c. 6
d. 2
e. 3
f. 5
g. 4
h. 8

20. a. 3
b. 2
c. 4
d. 6
e. 5
f. 1

21. d

22. d

23. b

24. a

25. a

26. d

INT-F13

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-F13

Subject: Instrumentation **Time: 30 Hrs.**

Duty: Participate in Continuing Education Activities
Task: Attend DCS Training

Objective(s):

Upon completion of this module the student will be able to:

a. Operate DCS Network;
b. Maintain DCS Network; and,
c. Troubleshoot DCS Network.

Instructional Materials:

DCS Network (such as Provox)
MASTER Handout (INT-F13-HO)
MASTER Laboratory Aid (INT-F13-LA)
MASTER Laboratory Worksheet (INT-F13-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-F12 "Attend PLC Training"

Introduction:

DCS Networks use computers and toe to PLCs to operate a plant. This is a very complex system. LANS are used to communicate between PLCs and DCS network.

Presentation Outline:

I. Physical Topology
II. Electrical Topology
III. Connecting Methodologies
IV. LAN
V. WAN

Practical Application:

Student will practice with DCS system.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-G1) dealing with learning to review and forecast spare parts inventory.

INT-F13-HO
Attend DCS Training
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Operate DCS Network;
b. Maintain DCS Network; and,
c. Troubleshoot DCS Network.

Module Outline:

I. Physical Topology
II. Electrical Topology
III. Connecting Methodologies
IV. LAN
V. WAN

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-F13-LW
Attend DCS Training
Attachment 3: **MASTER** Laboratory Worksheet

PROVOX/PLC PRACTICAL EXERCISE PROVOX		
NAME:		
SSN:		
Instructor Hits <P1>. <E>. & Lime Unloading is displayed		
	YES	NO
Have you used PROVOX before?		
Start 5M103 Conveyor to South Silo - In Reverse (<DSR> <3> <E> <SK >)		
Tell DSR3		
Stop 5M103 Conveyor to Lime Silo (<DSR> <3> <E>- <SK1>)		
Start Lime Unloading Sequence using 5HS-S1 (<DSR> <7> <E> - <SK2>)		
Change Lime Unloading Sequence to OFF by turning OFF 5HS-S1 (<DSR> <7> <E> <SK1>)		
Go to Display 13 (<SHOW DISPLAY #> <13> <E>)		
Show detail display parameters for 5LIC126-3 Hot Water Tank (<DSR> <2> <E> <SHOW DETAIL #> <E>)		
For 5LIC126-3, What is the Gain = 10.0		
For 5LIC126-3, What is the Reset = 0.100		
For 5LIC126-3, What is the Rate = 0.000		
Given ALM C TR is configured for a high alarm, what is the trip point? 100.00		
Given ALM C TR is configured for a high alarm, what is the deadband? 4.00		
Go back to last display (<SHOW LAST DISPLAY>) - should be display 13		
Go to Point Directory Display (<CTRL POINT #> or < DIR> <SK1>)		
Find 6M852 in Point Directory (use <PAGE FWD> to display)		
Pick DSR "0" in bottom field and show Detail On Point (<CTRL POINT #> <182> <E>)		
Return to Display 10 (SHOW DISPLAY#> <10> >E>)		
What is the range of analog input point accessed by DSR 15? (<DSR> <15> <E> <SHOW DETAIL #> <E>) 0-100		
Return to Display 10 (<SHOW DISPLAY #> <10> <E>) or (<SHOW LAST DISPLAY>)		

Name:_____ Date:_____

INT-F13
Attend DCS Training
Self-Assessment

1. _____ is a technique using a software program to periodically and continuously check the port address for data received or transmitted to.

2. _____ is a signal that varies continuously between maximum and minimum values.

3. Broadband uses analog wave forms, has a large band width (mega to giga hertz), and also uses _____ modulation.

4. The orderly exchange of data is called _____.

5. The computer system is made up of individual components working together as a system. The way they communicate is called network _____.

6. D_____ T_____ E_____

7. An operator _____ is a man/machine interface.

8. A(n) _____ station serves a computer on a network used primarily to run application software.

9. Computers can be connected into a W_____ A_____ N_____ that spans greater distances than LAN's. This system may make use of satellite, microwave and telephone systems.

10. A(n) _____ is a network using the token passing protocol and a ring topology.

11. DOS, Windows 95 and UNIX are _____.

12. The nonvolatile instructions that enable a computer to boot is called _____.

13. PC may mean _____ or _____.

14. Scada systems may cover _____.

15. Expert systems are based on _____.

INT-F13
Attend DCS Training
Self-Assessment Answer Key

1. Polling
2. Analog
3. Frequency
4. Handshaking
5. Protocol
6. Data, Terminal, Equipment
7. Interface
8. Work
9. Wide, Area, Network
10. Token Ring
11. Operating Systems
12. Firmware
13. Personal Computer, Programmable Controller
14. Many Miles
15. Artificial Intelligence

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and repair transmitters	C-12 Test different field sensing elements, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Calibrate transmitters	C-15 Tune controllers: pneumatic and electronic	C-16 Trouble-shoot and repair plant computing systems relating to process controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and repair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and configure smart field devices, i.e., transmitters and valves	C-35 Operate control systems including single element, cascade, ratio, and feedforward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Determine proper tools, equipment, and materials to perform the job	D-3 Coordinate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment isolation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibration procedures	D-8 Follow specifications and procedures	D-9 Perform algebraic operations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibration data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise procedures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Application of ISA/IEC standards	F-5 Understand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Understand personal computers	F-10 Attend on-going safety training courses	F-11 Participate in plant related training	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

INT-G1

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-G1

Subject: Instrumentation **Time: 6 Hrs.**

Duty: Maintain And Control Inventory
Task: Learn to Review and Forecast Spare Parts Inventory

Objective(s):

Upon completion of this module the student will be able to:
a. Review spare parts inventory; and,
b. Forecast spare parts inventory.

Instructional Materials:

MASTER Handout (INT-G1-HO)
MASTER Laboratory Worksheet (INT-G1-LW)

References:

Applied Production & Operation Management, Evans, West Publishers, Latest Edition
Understanding the Manufacturing Process, Harrington, Marcel Dekker Publishers, Latest Edition
Production Operation Management, Adam, Prentice Hall Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-F13 "Attend DCS Training"

Introduction:

Without parts inventory, parts replacement due to faulty parts would be impossible. This would mean ordering parts from vendors and waiting until they arrive to install. This could mean lengthy equipment shutdowns.

Presentation Outline:

I. Parts Nomenclature

II. Parts Familiarity
III. Vendor Name or Number
IV. Software Familiarity
V. Forecasting Characteristics

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-G2) dealing with preparing parts request.

INT-G1-HO
Learn to Review and Forecast Spare Parts Inventory
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Review spare parts inventory; and,
b. Forecast spare parts inventory.

Module Outline:

I. Parts Nomenclature
II. Parts Familiarity
III. Vendor Name or Number
IV. Software Familiarity
V. Forecasting Characteristics

INT-G1-LW
Learn to Review and Forecast Spare Parts Inventory
Attachment 2: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Review spare parts inventory;
   b. Make list of parts common characteristics;
   c. Identify common vendors; and,
   d. Use software to forecast inventory needs.

2. Student will demonstrate how to:
   a. Review spare parts inventory;
   b. Make list of parts common characteristics;
   c. Identify common vendors; and,
   d. Use software to forecast inventory needs.

3. Instructor will grade student's ability to:
   a. Review spare parts inventory;
   b. Make list of parts common characteristics;
   c. Identify common vendors; and,
   d. Use software to forecast inventory needs.

INT-G2

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-G2

Subject: Instrumentation **Time: 3 Hrs.**

Duty: Maintain And Control Inventory
Task: Prepare Parts Request

Objective(s):

Upon completion of this module the student will be able to:

a. Prepare parts request;
b. Explain functions of major equipment;
c. Pick out parts from exploded view;
d. Pick out parts from assembly view;
e. Pick out parts from composite view; and,
f. Research back order.

Instructional Materials:

MASTER Handout (INT-G2-HO)
MASTER Laboratory Worksheet (INT-G2-LW)

References:

Applied Production & Operation Management, Evans, West Publishers, Latest Edition
Understanding the Manufacturing Process, Harrington, Marcel Dekker Publishers, Latest Edition
Production Operation Management, Adam, Prentice Hall Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-G1 "Learn to Review and Forecast Spare Parts Inventory"

Introduction:

Parts request is first step toward acquiring all parts necessary to complete project.

Presentation Outline:

I. Exploded View
II. Composite View
III. Assembly View
IV. Pictorial View
V. Parts List

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-G3) dealing with verifying parts received.

INT-G2-HO
Prepare Parts Request
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Prepare parts request;
b. Explain functions of major equipment;
c. Pick out parts from exploded view;
d. Pick out parts from assembly view;
e. Pick out parts from composite view; and,
f. Research back order.

Module Outline:

I. Exploded View
II. Composite View
III. Assembly View
IV. Pictorial View
V. Parts List

INT-G2-LW
Prepare Parts Request
Attachment 2: **MASTER** Laboratory Worksheet

---

1. Instructor will:
   a. Draw example of exploded view;
   b. Draw example of assembly view; and,
   c. Draw example of composite view.

2. Student will:
   a. Draw example of exploded view;
   b. Draw example of assembly view; and,
   c. Draw example of composite view.

3. Instructor will grade student's ability to:
   a. Draw example of exploded view;
   b. Draw example of assembly view; and,
   c. Draw example of composite view.

INT-G3

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-G3

Subject: Instrumentation **Time: 2 Hrs.**

Duty: Maintain and Control Inventory
Task: Verify Parts Received

Objective(s):

Upon completion of this module the student will be able to:

a. Verify parts received;
b. Use packing list to verify parts received; and,
c. Distinguish between ordered and shipped parts.

Instructional Materials:

MASTER Handout (INT-G3-HO)
MASTER Laboratory Worksheet (INT-G3-LW)

References:

Applied Production & Operation Management, Evans, West Publishers, Latest Edition
Understanding the Manufacturing Process, Harrington, Marcel Dekker Publishers, Latest Edition
Production Operation Management, Adam, Prentice Hall Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-G2 "Prepare Parts Request"

Introduction:

Correct verification of parts received is very important in order to maintain accurate records.

Presentation Outline:

I. Parts Familiarity

II. Packing List
III. Packing List Components
IV. Back Order Procedures
V. Tracking Procedure

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a practical written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-G4) dealing with researching and verifying substitute specifications.

INT-G3-HO
Verify Parts Received
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Verify parts received;
b. Use packing list to verify parts received; and,
c. Distinguish between ordered and shipped parts.

Module Outline:

I. Parts Familiarity
II. Packing List
III. Packing List Components
IV. Back Order Procedures
V. Tracking Procedure

INT-G3-HO
Verify Parts Received
Attachment 2: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Verify parts received;
   b. Use packing list to verify parts received; and,
   c. Distinguish between ordered and shipped parts.

2. Student will demonstrate how to:
   a. Verify parts received;
   b. Use packing list to verify parts received; and,
   c. Distinguish between ordered and shipped parts.

3. Instructor will grade student's ability to:
   a. Verify parts received;
   b. Use packing list to verify parts received; and,
   c. Distinguish between ordered and shipped parts.

INT-G4

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-G4

Subject: **Instrumentation** **Time: 8 Hrs.**

Duty: **Maintain and Control Inventory**
Task: Research/Verify Substitute Specifications

Objective(s):

Upon completion of this module the student will be able to:

a. Substitute parts for parts that do not match exact characteristics;
b. Research substitute specifications; and,
c. Verify substitute specifications.

Instructional Materials:

MASTER Handout (INT-G4-HO)
MASTER Laboratory Worksheet (INT-G4-LW)

References:

Applied Production & Operation Management, Evans, West Publishers, Latest Edition
Understanding the Manufacturing Process, Harrington, Marcel Dekker Publishers, Latest Edition
Production Operation Management, Adam, Prentice Hall Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-G3 "Verify Parts Received"

Introduction:

When exact replacements are not available, substitution become important. If not able to substitute, valuable time is wasted.

Presentation Outline:

I. Flexible Part Characteristics

II. Non-Flexible Part Characteristics
III. Substitute Parameters

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of a practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-H1) dealing with troubleshooting, installing, maintaining, and operating motor starters.

INT-G4-HO
Research/Verify Substitute Specifications
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Substitute parts for parts that do not match exact characteristics;
b. Research substitute specifications; and,
c. Verify substitute specifications.

Module Outline:

I. Flexible Part Characteristics
II. Non-Flexible Part Characteristics
III. Substitute Parameters

INT-G4-LW
Research/Verify Substitute Specifications
Attachment 2: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Substitute parts for parts that do not match exact characteristics;
   b. Research substitute specifications; and,
   c. Verify substitute specifications.

2. Student will demonstrate how to:
   a. Substitute parts for parts that do not match exact characteristics;
   b. Research substitute specifications; and,
   c. Verify substitute specifications.

3. Instructor will grade student's ability to:
   a. Substitute parts for parts that do not match exact characteristics;
   b. Research substitute specifications; and,
   c. Verify substitute specifications.

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and repair transmitters	C-12 Test different field sensing elements, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Calibrate transmitters	C-15 Tune controllers: pneumatic and electronic	C-16 Trouble-shoot and repair plant computing systems relating to process controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and repair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and configure smart field devices, i.e., transmitters and valves	C-35 Operate control systems including single element, cascade, ratio, and feedforward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Determine proper tools, equipment, and materials to perform the job	D-3 Coordinate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment isolation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibration procedures	D-8 Follow specifications and procedures	D-9 Perform algebraic operations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibration data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise procedures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Application of ISA/IEC standards	F-5 Understand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Understand personal computers	F-10 Attend on-going safety training courses	F-11 Participate in plant related training	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

1012

1011

DutyH

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-H1

Subject: **Instrumentation** **Time: 25 Hrs.**

Duty: **Troubleshoot, Install, Maintain, And Operate Motor Control Systems**

Task: Troubleshoot, Install, Maintain, and Operate Motor Starters

Objective(s):

Upon completion of this module the student will be able to:

a. Operate motor starters;
b. Install motor starters;
c. Maintain motor starters; and,
d. Troubleshoot motor starters.

Instructional Materials:

MASTER Handout (INT-H1-HO)
MASTER Laboratory Aid (INT-H1-LA)
MASTER Laboratory Worksheet (INT-H1-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-G4 "Research/Verify Substitute Specifications"

Introduction:

Motor starters are used to control large loads such as motors, valves, pumps, compressors, etc. Motor starters are used to start, run, stop, reverse and ramp motors.

Presentation Outline:

I. Contactor
II. Motor Overloads
III. Full Line Motor Starters
IV. Primary Resistance Starters
V. Autotransformer Starters
VI. Part Winding Starters
VII. Star Delta Starters
VIII. Two Speed Starters
IX. Troubleshooting Motor Starters

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-H2) dealing with troubleshooting, installing, maintaining, and operating relays.

INT-H1-HO
Troubleshoot, Install, Maintain, and Operate Motor Starters
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Operate motor starters;
b. Install motor starters;
c. Maintain motor starters; and,
d. Troubleshoot motor starters.

Reading Assignments:

Electronic Motor Control, Delmar Publishers, Latest Edition"

Chapter	Title
23	Primer Resistance Starters
24	Autotransformer Starters
25	Part Winding Starters
26	Delta Starters
27	Two Speed Starters

Module Outline:

I. Contactor
II. Motor Overloads
III. Full Line Motor Starters
IV. Primary Resistance Starters
V. Autotransformer Starters
VI. Part Winding Starters

VII. Star Delta Starters
VIII. Two Speed Starters
IX. Troubleshooting Motor Starters

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Practice:

a. Contactor;
b. Motor overloads;
c. Full line motor starters;
d. Primary resistance starters;
e. Autotransformer starters;
f. Part winding starters;
g. Stat delta starters; and,
h. Two speed starters.

Name:_____ Date:_____

INT-H1
Troubleshoot, Install, Maintain, and Operate Motor Starters
Self-Assessment

1. What is a(an):

   a. Contactor?

   _____
   _____
   _____

   b. Motor overload?

   _____
   _____
   _____

   c. Full line motor starter?

   _____
   _____
   _____

   d. Primary resistance starter?

   _____
   _____
   _____

   e. Autotransformer starter?

   _____
   _____
   _____

   f. Part winding starter?

   _____
   _____
   _____

   g. Star delta starter?

   _____
   _____
   _____

h. **Two speed starter?**

_____

_____

_____

INT-H1

Troubleshoot, Install, Maintain, and Operate Motor Starters

Self-Assessment Answer Key

1.

a. Large control relay used to handle high currents and voltages.

b. Consist of heaters and normally closed contact used with contactor to control a motor.

c. Magnetic starter used with full line voltage.

d. Reduced voltage starters at first places resistors in series with motor. After a short time delay the resistors are bypassed and the motor continues to run.

e. Same as primary resistance starters except use autotransformers in place of resistors.

f. Requires special motor. Start motor with part of winding. After a time delay, place all of motor winding to circuit.

g. Start in a star configuration. After a time delay change to delta configuration.

h. Speed motor. Engage one speed with a magnetic starter. Engage another magnetic starter for another speed.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-H2

Subject: **Instrumentation** **Time: 12 Hrs.**

Duty: **Troubleshoot, Install, Maintain, and Operate Motor Control Systems**

Task: Troubleshoot, Install, Maintain, and Operate Relays

Objective(s):

Upon completion of this module the student will be able to:

a. Operate relays;
b. Maintain relays;
c. Troubleshoot relays; and,
d. Install relays.

Instructional Materials:

Control relay
Timing relay-pneumatic, electrical, and electronic
Solid state relay
MASTER Handout (INT-H2-HO)
MASTER Laboratory Aid (INT-H2-LA)
MASTER Laboratory Worksheet (INT-H2-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-H1 "Troubleshoot, Install, Maintain, and Operate Motor Starters"

Introduction:

Relays are essential components system. Control power is usually lower voltage and lower current. Relays take lower voltage and current and activate switches to control higher voltage and current components.

Presentation Outline:

I. Control Relay
II. Electrical Timing Relay
III. Pneumatic Timing Relay
IV. Electronic Timing Relay
V. Solid State Relay
VI. Phase Failure Relay
VII. Time Delay, Low Voltage Release Relay

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-H3) dealing with troubleshooting, installing, maintaining, and operating pushbuttons.

INT-H2-HO
Troubleshoot, Install, Maintain, and Operate Relays
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Operate relays;
b. Maintain relays;
c. Troubleshoot relays; and,
d. Install relays.

Reading Assignments:

Electronic Motor Control, Delmar Publishers, Latest Edition:

Chapter	Title
5	Relays and Contractors
6	Timing Relays
11	Phase Failure Relays
22	Time Delay, Low Voltage Release Relay

Module Outline:

I. Control Relay
II. Electrical Timing Relay
III. Pneumatic Timing Relay
IV. Electronic Timing Relay
V. Solid State Relay
VI. Phase Failure Relay
VII. Time Delay, Low Voltage Release Relay

INT-H2-LA
Troubleshoot, Install, Maintain, and Operate Relays
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-H2-LW
Troubleshoot, Install, Maintain, and Operate Relays
Attachment 3: **MASTER** Laboratory Worksheet

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1. Practice identifying:
   a. Control relay;
   b. Pneumatic timing relay;
   c. Electrical timing relay;
   d. Electronic timing relay;
   e. Solid state relay;
   f. Phase failure relay; and,
   g. Time delay, low voltage release relay.

2. Practice installing:
   a. Control relay;
   b. Pneumatic timing relay;
   c. Electrical timing relay;
   d. Electronic timing relay;
   e. Solid state relay;
   f. Phase failure relay; and,
   g. Time delay, low voltage release relay.

3. Practice maintaining:
   a. Control relay;
   b. Pneumatic timing relay;
   c. Electrical timing relay;
   d. Electronic timing relay;
   e. Solid state relay;
   f. Phase failure relay; and,
   g. Time delay, low voltage release relay.

4. Practice troubleshooting:
   a. Control relay;
   b. Pneumatic timing relay;
   c. Electrical timing relay;
   d. Electronic timing relay;
   e. Solid state relay;
   f. Phase failure relay; and,
   g. Time delay, low voltage release relay.

Name:_____ Date:_____

INT-H2
Troubleshoot, Install, Maintain, and Operate Relays
Self-Assessment

1. List the major parts of:
   a. Control relay.

   _____
   _____
   _____

   b. Pneumatic timing relay.

   _____
   _____
   _____

   c. Electronic timing relay.

   _____
   _____
   _____

   d. Solid state relay.

   _____
   _____
   _____

2. List common characteristics of:
   a. Control relay.

   _____
   _____
   _____

   b. Phase failure relay.

   _____
   _____
   _____

INT-H2
Troubleshoot, Install, Maintain, and Operate Relays
Self-Assessment Answer Key

1.

a. Coil, contact

b. Diaphragm coil-air operated, contact

c. RC circuit, contact

d. SCR or transistor used for coil and contact

2.

a. Used to conttol small loads at low voltages

b. If any one of a three phase circuit loses voltage, the phase failure relay causes the magnetic starter to drop out.

INSTRUMENTATION SERIES

MASTER Technical Module NO. INT-H3

Subject: **Instrumentation** **Time: 3 Hrs.**

Duty: **Troubleshoot, Install, Maintain, and Operate Motor Control Systems**

Task: Troubleshoot, Install, Maintain, and Operate Pushbuttons

Objective(s):

Upon completion of this module the student will be able to:

a. Operate pushbuttons;
b. Install pushbuttons;
c. Maintain pushbuttons; and,
d. Troubleshoot pushbuttons.

Instructional Materials:

Pushbuttons
MASTER Handout (INT-H3-HO)
MASTER Laboratory Aid (INT-H3-LA)
MASTER Laboratory Worksheet (INT-H3-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-H2 "Troubleshoot, Install, Maintain, and Operate Relays"

Introduction:

Push buttons are used as the input device to start, run, reverse, and stop a control sequence. Pushbuttons supply the tie between humans and the electrical controls.

Presentation Outline:

I. Pushbutton Familiarity
II. Pushbutton Operation
III. Pushbutton Installation
IV. Pushbutton Maintenance
V. Pushbutton Troubleshooting

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-H4) dealing with troubleshooting, installing, maintaining, and operating switches.

INT-H3-HO
Troubleshoot, Install, Maintain, and Operate Pushbuttons
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Operate pushbuttons;
b. Install pushbuttons;
c. Maintain pushbuttons; and,
d. Troubleshoot pushbuttons.

Reading Assignments:

Electrical Motor Control, Delmar Publishers, Latest Edition

Chapter	Title
4	Pushbutton Control

Module Outline:

I. Pushbutton Familiarity
II. Pushbutton Operation
III. Pushbutton Installation
IV. Pushbutton Maintenance
V. Pushbutton Troubleshooting

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-H3-LW
Troubleshoot, Install, Maintain, and Operate Pushbuttons
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Answer questions assigned by instructor from textbook.

2. Practice installing push buttons in housing.

3. Practice ID pushbuttons:
   - A. Standard vs. heavy duty
   - B. Green P.B.
   - C. Red P.B.
   - D. Mushroom head P.B.
   - E. Selector switch
     1. 2 position
     2. 3 position
   - F. Selector switch
     1. NO
     2. NC
     3. NO-NC

4. Practice installing contact block to head

5. Practice troubleshooting a bad pushbutton.

Name:_____ Date:_____

INT-H3
Troubleshoot, Install, Maintain, and Operate Pushbuttons
Self-Assessment

1. What does a red pushbutton indicate?

2. What does a green pushbutton indicate?

3. What is symbol for normally closed pushbutton?

4. What is a contact block?

5. What is a 2 position selector switch?

6. What is a 3 position selector switch?

INT-H3
Troubleshoot, Install, Maintain, and Operate Pushbuttons
Self-Assessment Answer Key

1. Stop
2. Start
3. Two parallel lines with a single crosshatch line
4. Either normally open or normally closed contact in a block configuration.
5. On or Off
6. Hand, Off, Automatic

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-H4

Subject: **Instrumentation** **Time: 15 Hrs.**

Duty: **Troubleshoot, Install, Maintain, and Operate Motor Control Systems**

Task: Troubleshoot, Install, Maintain, and Operate Switches

Objective(s):

Upon completion of this module the student will be able to:

a. Operate switches;
b. Maintain switches;
c. Troubleshoot switches; and,
d. Install switches.

Instructional Materials:

Limit switch
Photo and electric switch
Proximity switch
Thermal switch
Pressure switch
Selector switch
Drum switch
Toggle switch
MASTER Handout (INT-H4-HO)
MASTER Laboratory Aid (INT-H4-LA)
MASTER Laboratory Worksheet (INT-H4-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-H3 "Troubleshoot, Install, Maintain, and Operate Pushbuttons"

Introduction:

Switches in a control system control the process. A switch may be a manual or automatic input to control an activity or sequence of events.

Presentation Outline:

I. Toggle Switch
II. Limit Switch
III. Selector Switch
IV. Thermal Switch
V. Pressure Switch
VI. Photoelectric Switch
VII. Proximity Switch
VIII. Drum Switch

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-H5) dealing with troubleshooting, installing, maintaining, and operating DCS networks.

INT-H4-HO
Troubleshoot, Install, Maintain, and Operate Switches
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Operate switches;
b. Maintain switches;
c. Troubleshoot switches; and,
d. Install switches.

Reading Assignments:

Electric Motor Control, Delmar Publishers, Latest Edition:

Chapter	Title
4	Pushbutton
8	Float Switches
9	Flow Switches
10	Limit Switches
13	Temperature Switches

Module Outline:

I. Toggle Switch
II. Limit Switch
III. Selector Switch
IV. Thermal Switch

V. Pressure Switch
VI. Photoelectric Switch
VII. Proximity Switch
VIII. Drum Switch

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-H4-LW
Troubleshoot, Install, Maintain, and Operate Switches
Attachment 3: **MASTER** Laboratory Worksheet

Practice:

1. Operating switches;
2. Maintaining switches;
3. Troubleshooting switches; and,
4. Installing switches.

Name:_____ Date:_____

INT-H4
Troubleshoot, Install, Maintain, and Operate Switches
Self-Assessment

What us a:

1. Toggle switch?

2. Limit switch?

3. Selector switch?

4. Thermal switch?

5. Pressure switch?

6. Photoelectric switch?

7. Proximity switch?

8. Drum switch?

INT-H4

Troubleshoot, Install, Maintain, and Operate Switches

Self-Assessment Answer Key

1. Small handle activated switch.

2. Switch controlled by mechanical linkage.

3. A switch that is manually operated in a rotating motion.

4. Temperature change, change switch position.

5. Pressure change, change switch position.

6. Change in light intensity changes switch position.

7. A change in magnetic field changes switch position.

8. Used to reverse manually a motor. The switch uses fingers held by spring pressure against contact surfaces on the outside of a rotating cylinder cam.

INT-H5

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-H5

Subject: Instrumentation **Time: 30 Hrs.**

Duty: Troubleshoot, Install, Maintain, and Operate Motor Control Systems

Task: Troubleshoot, Install, Maintain, and Operate DCS Networks

Objective(s):

Upon completion of this module the student will be able to:

a. Operate DCS network;
b. Maintain DCS network; and,
c. Troubleshoot DCS network.

Instructional Materials:

DCS network (such as Provox)
MASTER Handout (INT-H5-HO)
MASTER Laboratory Aid (INT-H5-LA)
MASTER Laboratory Worksheet (INT-H5-LW)
MASTER Self-Assessment

References:

Instrumentation, Kirk, ATP Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-H4 "Troubleshoot, Install, Maintain, and Operate Switches"

Introduction:

DCS Networks use computers and tow to PLCs to operate a plant. This is a very complex system. LANS are used to communicate between PLCs and DCS network.

Presentation Outline:

I. Physical Topology
II. Electrical Topology
III. Connecting Methodologies
IV. LAN
V. WAN

Practical Application:

Student will practice with DCS system.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-H6) dealing with preparing and updating ladder and/or logic diagrams.

INT-H5-HO
Troubleshoot, Install, Maintain, and Operate DCS Networks
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Operate DCS network;
b. Maintain DCS network; and,
c. Troubleshoot DCS network.

Module Outline:

I. Physical Topology
II. Electrical Topology
III. Connecting Methodologies
IV. LAN
V. WAN

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-H5-LW
Troubleshoot, Install, Maintain, and Operate DCS Networks
Attachment 3: **MASTER** Laboratory Worksheet

PROVOX/PLC PRACTICAL EXERCISE PROVOX		
NAME:		
SSN:		
Instructor Hits <P1>. <E>. & Lime Unloading is displayed		
	YES	NO
Have you used PROVOX before?		
Start 5M103 Conveyor to South Silo - In Reverse (<DSR> <3> <E> <SK >)		
Tell DSR3		
Stop 5M103 Conveyor to Lime Silo (<DSR> <3> <E>- <SK1>)		
Start Lime Unloading Sequence using 5HS-S1 (<DSR> <7> <E> - <SK2>)		
Change Lime Unloading Sequence to OFF by turning OFF 5HS-S1 (<DSR> <7> <E> <SK1>)		
Go to Display 13 (<SHOW DISPLAY #> <13> <E>)		
Show detail display parameters for 5LIC126-3 Hot Water Tank (<DSR> <2> <E> <SHOW DETAIL #> <E>)		
For 5LIC126-3. What is the Gain = 10.0		
For 5LIC126-3. What is the Reset = 0.100		
For 5LIC126-3. What is the Rate = 0.000		
Given ALM C TR is configured for a high alarm. what is the trip point? 100.00		
Given ALM C TR is configured for a high alarm. what is the deadband? 4.00		
Go back to last display (<SHOW LAST DISPLAY>) - should be display 13		
Go to Point Directory Display (<CTRL POINT#> or < DIR> <SK1>)		
Find 6M852 in Point Directory (use <PAGE FWD> to display)		
Pick DSR "0" in bottom field and show Detail On Point (<CTRL POINT #> <182> <E>)		
Return to Display 10 (SHOW DISPLAY#> <10> >E>)		
What is the range of analog input point accessed by DSR 15? (<DSR> <15> <E> <SHOW DETAIL #> <E>) 0-100		
Return to Display 10 (<SHOW DISPLAY #> <10> <E>) or (<SHOW LAST DISPLAY>)		

Name:_____ Date:_____

INT-H5
Troubleshoot, Install, Maintain, and Operate DCS Networks
Self-Assessment

1. _____ is a technique using a software program to periodically and continuously check the port address for data received or transmitted to.

2. _____ is a signal that varies continuously between maximum and minimum values.

3. Broadband uses analog wave forms, has a large band width (mega to giga hertz), and also uses _____ modulation.

4. Baseband uses _____ signals with a limited band width.

5. The orderly exchange of data is called _____.

6. The computer system is made up of individual components working together as a system. The way they communicate is called network _____.

7. D_____ T_____ E_____

8. A(n) network _____ interconnects sub networks together.

9. An operator _____ is a man/machine interface.

10. A(n)_____station serves a computer on a network used primarily to run application software.

11. A(n)_____connects to a network that provides file storage for dumb terminals on a network.

12. A(n)_____ connects a mainframe to a LAN and translate local level protocols and handles the speed differences between two networks.

13. Computers can be connected into a W_____ A_____ N_____ that spans greater distances than LANs. This system may make use of satellite, microwave and telephone systems.

14. A(n) D_____ H_____ is a high speed communication link that includes the physical connection and the hardware and software that is needed to transfer data on the system.

15. A(n) _____ is a network using the token passing protocol and a ring topology.

15. D_____ C_____-_____ E_____

16. C_____ T_ S___

17. C_____ D_____

INT-H5
Troubleshoot, Install, Maintain, and Operate DCS Networks
Self-Assessment Answer Key

1. Polling
2. Analog
3. Frequency
4. Unipolar Modulation
5. Handshaking
6. Protocol
7. Data Terminal Equipment
8. Interface
9. Work
10. Server
11. Server
12. Wide, Area, Network
13. Data Highway
14. Token Ring
15. Data Current-Terminating Equipment
16. Clear to Send
17. Carrier Detect

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-H6

Subject: **Instrumentation** **Time: 15 Hrs.**

Duty: **Troubleshoot, Install, Maintain, and Operate Motor Control Systems**

Task: Prepare and Update Ladder And/or Logic Diagrams

Objective(s):

Upon completion of this module the student will be able to:

a. Prepare ladder diagrams;
b. Update ladder diagrams;
c. Prepare logic diagrams; and,
d. Update logic diagrams.

Instructional Materials:

MASTER Handout (INT-H6-HO)
MASTER Laboratory Aid (INT-H6-LA)
MASTER Laboratory Worksheet (INT-H6-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-H5 "Troubleshoot, Install, Maintain, and Operate DCS Networks"

Introduction:

Ladder diagrams are written using symbols. Ladder diagram depict sequence of operation of electrical components used with a machine or machines.

Presentation Outline:

I. Symbols
II. Wiring Diagrams
III. Ladder Diagrams
IV. Logic Diagrams

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-H7) dealing with programming PLCs.

INT-H6-HO
Prepare and Update Ladder And/or Logic Diagrams
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Prepare ladder diagrams;
b. Update ladder diagrams;
c. Prepare logic diagrams; and,
d. Update logic diagrams.

Reading Assignments:

Electric Motor Control, Delmar Publishers, Latest Edition:

Chapter	Title
14	Symbols
15	Interpretation and Application of Wiring and Elementary Diagrams
21	Sequence Control

Module Outline:

I. Symbols
II. Wiring Diagrams
III. Ladder Diagrams
IV. Logic Diagrams

INT-H6-LA
Prepare and Update Ladder And/or Logic Diagrams
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Practice Wiring:

1. Symbols;
2. Wiring diagrams;
3. Ladder diagrams; and,
4. Logic diagrams.

Name:_____ Date:_____

INT-H6
Prepare and Update Ladder And/or Logic Diagrams
Self-Assessment

1. These diagrams are drawn to a scale.
   A. Wiring
   B. Ladder
   C. Schematic
   D. Logic
   E. None of These

2. These diagrams can use NOT circuits.
   A. Wiring
   B. Ladder
   C. Schematic
   D. Logic
   E. None of These

3. These diagrams use rails.
   A. Wiring
   B. Ladder
   C. Schematic
   D. Logic
   E. None of These

4. These diagrams can use OR circuits.
   A. Wiring
   B. Ladder
   C. Schematic
   D. Logic
   E. None of These

5. These diagrams use symbols, not drawn to a scale, not use logic components, not use rails.
   A. Wiring
   B. Ladder
   C. Schematic
   D. Logic
   E. None of These

6. These diagrams show components as they are placed physically.
   A. Wiring
   B. Ladder
   C. Schematic
   D. Logic
   E. None of These

7. These diagrams use a single line to indicate one, two, three, or four conductors. Used by power companies a great deal.
   A. Wiring
   B. Ladder
   C. Schematic
   D. Logic
   E. None of These

INT-H6
Prepare and Update Ladder And/or Logic Diagrams
Self-Assessment Answer Key

1. A
2. D
3. B
4. D
5. C
6. A
7. E

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-H7

Subject: Instrumentation **Time: 60 Hrs.**

Duty: Troubleshoot, Install, Maintain, and Operate Motor Control Systems

Task: Program PLCs

Objective(s):

Upon completion of this module the student will be able to:

a. Identify major components of PLCs;
b. Program PLCs:
   1. Examine ON;
   2. Examine OFF;
   3. Output energize;
   4. Timers;
   5. Counter;
   6. Output latch;
   7. Master control relay;
   8. SFLs;
   9. Modes; and,
   10. PID.

Instructional Materials:

A.B. PLC 5/10 or other PLC
Vendor manuals
MASTER Handout (INT-H7-HO)
MASTER Laboratory Aid (INT-H7-LA)
MASTER Laboratory Worksheet (INT-H7-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-H6 "Prepare and Update Ladder And/or Logic Diagrams"

Introduction:

PLCs are computer based, industrial, reprogramming machines. Their popularity is growing in industry. Programmable controllers are a ladder logic technique for programming. The flexibility of PLCs is phenomenal.

Presentation Outline:

I. Major Parts of PLC
II. Number Systems
III. Logic
IV. Inputs, Outputs
V. Timers
VI. Counter
VII. Master Control Relays
VIII. SFCs
IX. Modes
X. PID

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

MASTER Technical Module (INT-H8) dealing with troubleshooting, installing, maintaining and operating PLCs.

INT-H7-HO
Program PLCs
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify major components of PLCs;
b. Program PLCs;
   1. Examine ON;
   2. Examine OFF;
   3. Output energize;
   4. Timers;
   5. Counter;
   6. Output latch;
   7. Master control relay;
   8. SFLs;
   9. Modes; and,
   10. PID.

Reading Assignments:

Programmable Controllers And Design, Sequential Logic, Files, HBJ Publishing, Latest Edition:

Chapter	Title
1	Sequential Control
3	Relay Logic
4	Digital Logic
6	Programmable Controllers
7	Devices Used In Relay Logic
8	Processor Memory

9	Ladder Logic
10	Timer and Counter Instructions
14	Program Control Instructions
17	PLC Programming Languages

Module Outline:

I. Major Parts of PLC
II. Number Systems
III. Logic
IV. Inputs, Outputs
V. Timers
VI. Counter
VII. Master Control Relays
VIII. SFCs
IX. Modes
X. PID

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-H7-LW
Program PLCs
Attachment 3: **MASTER** Laboratory Worksheet

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1. Student will practice programming a PLC:
   a. Major parts of PLC;
   b. Number systems;
   c. Logic;
   d. Inputs, outputs;
   e. Timers;
   f. Counter;
   g. Master control relays;
   h. SFCs;
   i. Modes; and,
   j. PID.

2. Instructor will grade practical exercises.

Name:_____ Date:_____

INT-H7
Program PLCs
Self-Assessment

Construct a Ladder Program which contains:

1. One (1) software coded Emergency Stop circuit, using two (2) maintained position selector switches.

2. Multiple Start/Stop circuit with two Start/Stop stations and one motor output, use momentary push buttons, use one of Start PB pilot lamps as the output for the motor.

3. Do all the necessary documentation to understand the program.

Construct another Ladder Program which contains:

4. Using CTU/CTD Counters along with TON/TOF Timers in a program that controls two gates to a parking lot with a capacity of 100 vehicles. One gate is IN and the other is OUT. You have one inductive loop before each gate to sense vehicles and you need a time delay of 8 seconds to prevent the gate from closing on the entering or leaving vehicles. Vehicles can leave at any time after paying a coin to get in. Vehicles can enter any time the lot is not full. There needs to be a warning device of some type to let outside vehicles know that the lot is full.

Take the initial circuit that was developed with the multiple start-stop-emergency stop pushbuttons and develop a new circuit as above with the following additional items:

5. Using a TON timer, delay the seal-in of the motor for three (3) seconds (a way to verify that everything is functioning correctly). Make the timer automatically reset if the start button is released.

6. Using a TOF timer, allow the motor to run for ten (10) seconds, and then turn off the motor, automatically resetting the timer.

7. Use a CTU counter to count five (5) complete cycles of the motor, allowing a count-up after the TOF run timer times out. After the count out, do not allow the motor to restart. (This is not as easy as it may sound.)

8. Use a key reset switch to reset the CTU and the circuit.

Write a program that does the following, using the following instructions - TON, CMP, LIM, CTU, RES:

9. Turns a light on at 12 seconds.

10. Turns another light on at 18 seconds.

11. Turns another light on between 20 and 25 seconds.

12. Turns another light on after 30 seconds.

13. Automatically recycles.

14. Counts the number of cycles.

INSTRUMENTATION SERIES

MASTER Technical Module No. INT-H8

Subject: **Instrumentation** **Time: 20 Hrs.**

Duty: **Troubleshoot, Install, Maintain, and Operate Motor Control Systems**

Task: Troubleshoot, Install, Maintain and Operate PLCs

Objective(s):

Upon completion of this module the student will be able to:

a. Operate PLC;
b. Maintain PLC; and,
c. Troubleshoot PLC.

Instructional Materials:

A.B. PLC 5/10 or equal
MASTER Handout (INT-H8-HO)
MASTER Laboratory Aid (INT-H8-LA)
MASTER Laboratory Worksheet (INT-H8-LW)
MASTER Self-Assessment

References:

Feedback Control of Dynamic Systems, Franklin, Addison Wesley Publishers, Latest Edition
Automated Process Control Electronics, Harrington, Delmar Publishers, Latest Edition
Electrical and Basic Electronics, Matt, Goodheart-Willcox Publishers, Latest Edition
Exploring Electricity/Electronics, Delmar Publishers, Latest Edition

Student Preparation:

Students should have previously completed the following Technical Modules:
INT-H7 "Program PLCs"

Introduction:

PLCs allow one to troubleshoot.

Presentation Outline:

I. Major Parts of PLC
II. PLC Operation
III. PLC Modes
IV. PLC Maintenance
V. PLC Troubleshooting

Practical Application:

Students will use PLC as a troubleshooting tool. The PLC is a very complete machine.

Evaluation and/or Verification:

Successful completion of this technical module will be based on the student's successful completion of the written and practical evaluation.

Summary:

Review the main lesson points using the objectives as a guide discussion and answer student questions.

Next Lesson Assignment:

This completes the Instrumentation Modules.

INT-H8-HO
Troubleshoot, Install, Maintain and Operate PLCs
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Operate PLC;
b. Maintain PLC; and,
c. Troubleshoot PLC.

Reading Assignments:

Programmable Controllers and Designing Sequential, Files, HBJ Publishing, Latest Edition:

Chapter	Title
5	Safety Grouting, Troubleshooting, Maintaining
18	Select A PLC

Module Outline:

I. Major Parts of PLC
II. PLC Operation
III. PLC Modes
IV. PLC Maintenance
V. PLC Troubleshooting

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop:
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-H8-LW
Troubleshoot, Install, Maintain and Operate PLCs
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Student will practice:
   a. Operating PLC;
   b. Maintaining PLC; and,
   c. Troubleshooting PLC.

2. Instructor will grade based on student's performance.

Name:_____ Date:_____

INT-H8
Troubleshoot, Install, Maintain and Operate PLCs
Self-Assessment

1. Under normal operating conditions, the personal computer _____ to interface with the PLC.
   a. Is needed
   b. Will not be needed
   c. Is needed at all times
   d. Will only be needed

2. General start-up procedures include setting up the _____ and the _____ in the PLC and the personal computer.
   a. Computer, software
   b. CPU, memory
   c. Memory, I/O
   d. Hardware, software

3. A _____ is a device that installs in the serial port on the computer to enable the computer to run the PLC programming software.
   a. Hardware key
   b. EEPROM
   c. Control relay
   d. I/O group

4. Fill in the blank with ON if the description is of on-line programming. Fill in the blank with OFF if the description is of off-line programming.
   _____ a. Personal computer is not connected to the PLC.
   _____ b. Used to develop and test a ladder logic program.
   _____ c. Personal computer is connected to the PLC.
   _____ d. Allows debugging before running the program.
   _____ e. Used for final adjustments to program.
   _____ f. Requires strict safety precautions.

5. Match the following kinds of reports with their descriptions.

_____ a. ladder logic
_____ b. cross-reference listing
_____ c. status report
_____ d. histogram

1. Report of history of activity at a specified address
2. Report of status information at a given time
3. Report of any or all programmed logic
4. Report that tells where else in the ladder logic program an addressed item appears

6. The data table stores _____ information about the PLC.
   a. ASCII
   b. Status
   c. Program file
   d. Register

7. Besides the user memory, processor memory organization has a _____ area that holds the operating system for the PLC.
   a. Factory programmed memory
   b. EEPROM
   c. PROM
   d. RAM

8. The input image table stores status of all real world _____.
   a. Outputs
   b. Output modules
   c. Inputs
   d. Data files

9. The output image table stores status of all real world _____.
   a. Inputs
   b. Input modules
   c. Outputs
   d. Data files

10. Timer and counter storage stores _____, _____, and _____ data from timers and counters.
    a. Status, preset, accumulated
    b. Status, preset, discrete
    c. Status, accumulated, discrete
    d. Preset, accumulated, discrete

11. The PLC scan cycle continuously examines and updates _____, executes the _____, and updates _____.
    a. CPU, ROM, outputs
    b. CPU, RAM, outputs
    c. Inputs, ladder logic diagram, RAM
    d. Inputs, ladder logic program, outputs

12. A ladder logic diagram shows the logical sequence of _____ and _____ in a circuit.
    a. Inputs, data files
    b. Outputs, data files
    c. Inputs, Outputs
    d. Data files, nested branches

13. Ladder logic diagrams illustrate timers and counters with relay coils or _____.
    a. Function blocks
    b. Invertors
    c. Logic gates
    d. Discrete modules

14. A timer times out when the _____ equals the _____.
    a. Binary number, octal number
    b. Instruction, outputs
    c. Bit address, bit data file
    d. Accumulated value, preset value

15. An ON-DELAY (TON) timer _____ energizing its contact for a given time, or it measures the length of time an activity continues.
    a. Delays
    b. Starts
    c. Immediately
    d. Stops

16. Match the following words and definitions:

____ a. TON
____ b. RTO
____ c. Preset value
____ d. Accumulated value
____ e. Time base
____ f. Reset
____ g. Done bit

1. Amount of time timer is set to run
2. ON-DELAY timer
3. Retentive timer
4. Changes from zero to one when accumulated value equals preset value
5. Unit in which time is measured
6. Amount of time the timer has run
7. Accumulated time goes to zero

17. A retentive timer retains its _____ when power is interrupted.

a. Present value
b. Accumulated value
c. Starting value
d. Data file

18. A _____ can be used to keep track of the number of times a contact changes from open to closed.

a. Counter
b. Timer
c. Control relay
d. Done bit

19. Match the following terms and definitions.

___ a. CTU
___ b. CTD
___ c. Up/down counter
___ d. Preset value
___ e. Accumulated value
___ f. Done bit
___ g. Enabling contact
___ h. Reset

1. Counter that subtracts one from its count each time an event happens.
2. Number of times counter is set to count to.
3. Number of times counter has counted.
4. Trigger for counter function block.
5. Changes from zero to one when accumulated value equals preset value.
6. Counter that adds and subtracts events from the same register.
7. Counter that adds one to it count each time an event happens.
8. Accumulated value goes to zero.

20. Match the following terms and symbols:

___ a. =
___ b. not equal to symbol
___ c. >
___ d. equal to or greater than symbol
___ e. <
___ f. equal to or less than symbol

1. less than or equal to
2. not equal to
3. equal to
4. greater than
5. less than
6. greater than or equal to

21. The comparison function block uses the _____ label and specific symbol for the comparison to be made between the first register and the second register.

a. TON
b. JMP
c. MCR
d. CMP

22. When the MCR in the PLC is true, the rungs that follow it are _____. When the MCR in the PLC is false, the rungs that follow it are de-energized.
    a. De-energized
    b. True
    c. False
    d. Energized

23. MCR zones should not include _____ outputs that can cause invalid results that could lead to personal injury or equipment damage.
    a. Non retentive
    b. Retentive
    c. Unlatched
    d. Master control relay

24. Jump is the internal relay instruction for the PLC scan to _____ rungs that follow it.
    a. Skip
    b. Convert
    c. Invert
    d. Control

25. The jump instruction must be _____ for the PLC to jump the rungs.
    a. True
    b. False
    c. Off
    d. Delayed

26. The _____ contact with the same address as the JMP relay ends the jumped zone.
    a. Normally open
    b. Normally closed
    c. Time delay
    d. Label (LBL)

INT-H8
Troubleshoot, Install, Maintain and Operate PLCs
Self-Assessment Answer Key

1. b

2. d

3. a

4. a. Off
   b. OFF
   c. On
   d. Off
   e. On
   f. On

5. a. 3
   b. 4
   c. 2
   d. 1

6. b

7. a

8. c

9. c

10. a

11. d

12. c

13. c

14. d

15. a

16. a. 2
    b. 3
    c. 1
    d. 6
    e. 5
    f. 7
    g. 4

17. b

18. a

19. a. 7
    b. 1
    c. 6
    d. 2
    e. 3
    f. 5
    g. 4
    h. 8

20. a. 3
    b. 2
    c. 4
    d. 6
    e. 5
    f. 1

21. d

22. d

23. b

24. a

25. a

26. d

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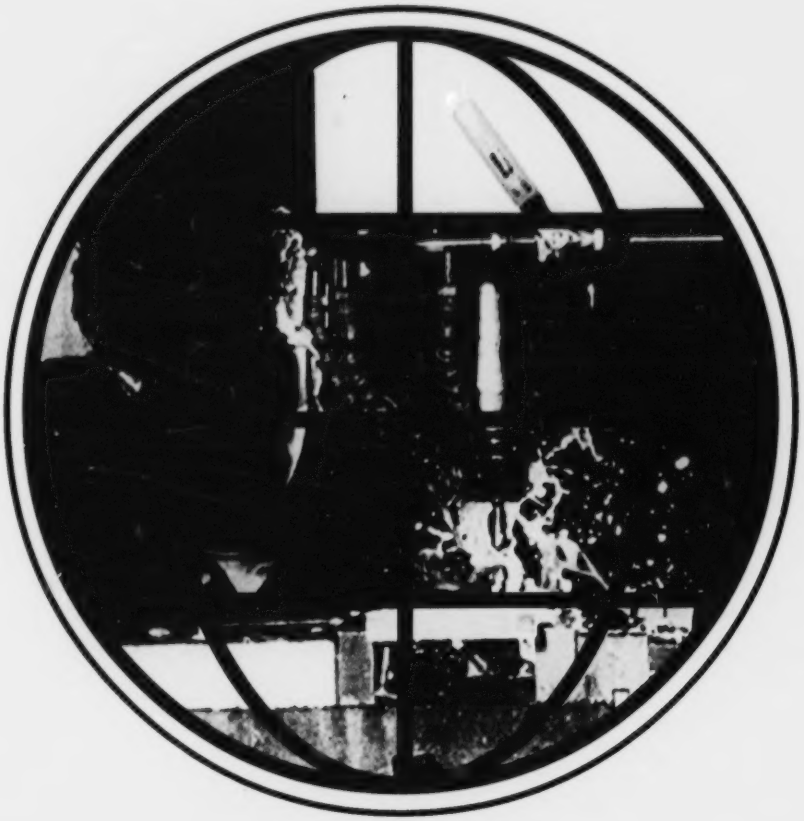

Instrumentation Series

STUDENT LABORATORY MANUAL

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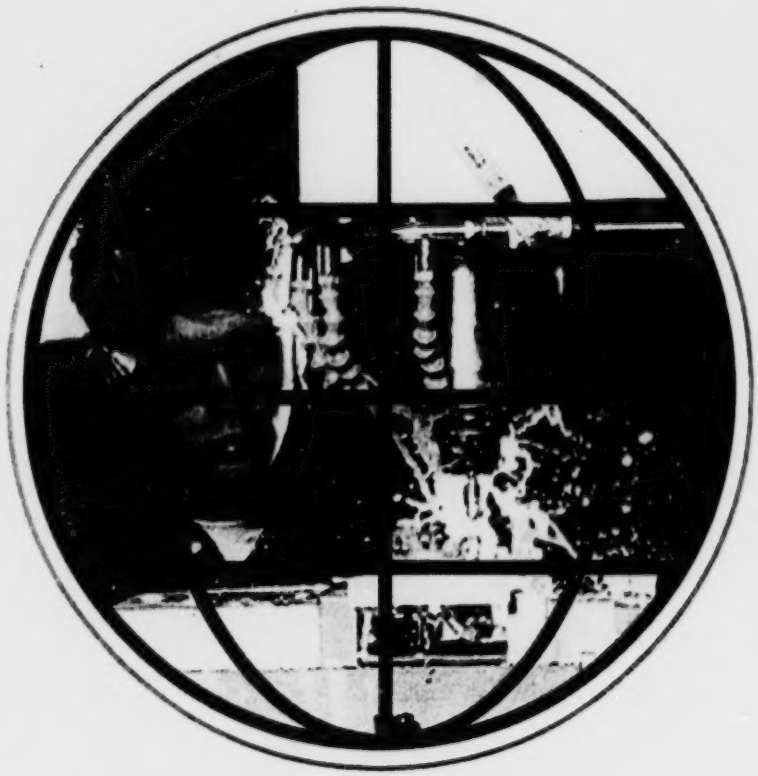
Supported by the National Science Foundation's Advanced Technological Education Program

MASTER

MACHINE TOOL ADVANCED SKILLS TECHNOLOGY EDUCATIONAL RESOURCES

A consortium of educators and industry

EDUCATIONAL RESOURCES FOR THE MACHINE TOOL INDUSTRY



Instrumentation Series

STUDENT LABORATORY MANUAL

Supported by the National Science Foundation's Advanced Technological Education Program

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Advanced Technological Education Program

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MASTER Consortia of Employers and Educators

MASTER has built upon the foundation which was laid by the Machine Tool Advanced Skills Technology (MAST) Program. The MAST Program was supported by the U.S. Department of Education - Office of Vocational and Adult Education. Without this prior support MASTER could not have reached the level of quality and quantity that is contained in these project deliverables.

MASTER DEVELOPMENT CENTERS
Augusta Technical Institute - Central Florida Community College - Itawamba Community College - Moraine Valley Community College - San Diego City College (CACT) - Springfield Technical Community College - Texas State Technical College

INDUSTRIES
AB Lasers - AIRCAP/MTD - ALCOA - American Saw - AMOCO Performance Products - Automatic Switch Company - Bell Helicopter - Bowen Tool - Brunner - Chrysler Corp. - Chrysler Technologies - Conveyor Plus - Darr Caterpillar - Davis Technologies - Delta International - Devon - D. J. Plastics - Eaton Leonard - EBTEC - Electro-Motive - Emergency One - Eureka - Foster Mold - GeoDiamond/Smith International - Greenfield Industries - Hunter Douglas - Industrial Laser - ITT Engineered Valve - Kaiser Aluminum - Krueger International. - Laser Fare - Laser Services - Lockheed Martin - McDonnell Douglas - Mercury Tool - NASSCO - NutraSweet - Rapistan DEMAG - Reed Tool - ROHR, International - Searle - Solar Turbine - Southwest Fabricators - Smith & Wesson - Standard Refrigeration - Super Sagless - Taylor Guitars - Tecumseh - Teledyne Ryan - Thermal Ceramics - Thomas Lighting - FMC, United Defense - United Technologies Hamilton Standard

COLLEGE AFFILIATES
Aiken Technical College - Bevil Center for Advanced Manufacturing Technology - Chicago Manufacturing Technology Extension Center - Great Lakes Manufacturing Technology Center - Indiana Vocational Technical College - Milwaukee Area Technical College - Okaloosa-Walton Community College - Piedmont Technical College - Pueblo Community College - Salt Lake Community College - Spokane Community College - Texas State Technical Colleges at Harlington, Marshall, Sweetwater

FEDERAL LABS
Jet Propulsion Lab - Lawrence Livermore National Laboratory - L.B.J. Space Center (NASA) - Los Alamos Laboratory - Oak Ridge National Laboratory - Sandia National Laboratory - Several National Institute of Standards and Technology Centers (NIST) - Tank Automotive Research and Development Center (TARDEC) - Wright Laboratories

SECONDARY SCHOOLS
Aiken Career Center - Chicopee Comprehensive High School - Community High School (Moraine, IL) - Connally ISD - Consolidated High School - Evans High - Greenwood Vocational School - Hoover Sr. High - Killeen ISD - LaVega ISD - Lincoln Sr. High - Marlin ISD - Midway ISD - Moraine Area Career Center - Morse Sr. High - Point Lamar Sr. High -

Pontotoc Ridge Area Vocational Center - Putnam Vocational High School - San Diego Sr. High - Tupelo-Lee Vocational Center - Waco ISD - Westfield Vocational High School

ASSOCIATIONS

American Vocational Association (AVA) - Center for Occupational Research and Development (CORD) - CIM in Higher Education (CIMHE) - Heart of Texas Tech-Prep - Midwest (Michigan) Manufacturing Technology Center (MMTC) - National Coalition For Advanced Manufacturing (NACFAM) - National Coalition of Advanced Technology Centers (NCATC) - National Skills Standards Pilot Programs - National Tooling and Machining Association (NTMA) - New York Manufacturing Extension Partnership (NYMEP) - Precision Metalforming Association (PMA) - Society of Manufacturing Engineers (SME) - Southeast Manufacturing Technology Center (SMTC)

MASTER PROJECT EVALUATORS

Dr. James Hales, East Tennessee State University and William Ruxton, formerly with the National Tooling and Machine Association (NTMA)

NATIONAL ADVISORY COUNCIL MEMBERS

The National Advisory Council has provided input and guidance into the project since the beginning. Without their contributions, MASTER could not have been nearly as successful as it has been. Much appreciation and thanks go to each of the members of this committee from the project team.

Dr. Hugh Rogers-Dean of Technology-Central Florida Community College
Dr. Don Clark-Professor Emeritus-Texas A&M University
Dr. Don Edwards-Department of Management-Baylor University
Dr. Jon Botsford-Vice President for Technology-Pueblo Community College
Mr. Robert Swanson-Administrator of Human Resources-Bell Helicopter, TEXTRON
Mr. Jack Peck-Vice President of Manufacturing-Mercury Tool & Die
Mr. Don Hancock-Superintendent-Connally ISD

SPECIAL RECOGNITION

Dr. Hugh Rogers recognized the need for this project, developed the baseline concepts and methodology, and pulled together industrial and academic partners from across the nation into a solid consortium. Special thanks and singular congratulations go to Dr. Rogers for his extraordinary efforts in this endeavor.

Dr. Don Pierson served as the Principal Investigator for the first two years of MASTER. His input and guidance of the project during the formative years was of tremendous value to the project team. Special thanks and best wishes go to Dr. Pierson during his retirement and all his worldly travels.

All findings and deliverables resulting from MASTER are primarily based upon information provided by the above companies, schools and labs. We sincerely thank key personnel within these organizations for their commitment and dedication to this project. Including the national survey, more than 2,800 other companies and organizations participated in this project. We commend their efforts in our combined attempt to reach some common ground in precision manufacturing skills standards and curriculum development.

MASTER DEVELOPMENT CENTER, AUGUSTA, GA
Center for Advanced Technology
Augusta Technical Institute

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Manufacturing in the Augusta Region

Augusta is the second largest city in Georgia and manufacturing represents the largest sector of the Augusta economy. The region is home to 810 manufacturers employing 89,717 people, an industrial base consisting of about 75% process control and 25% discrete parts production facilities. Major areas of emphasis for industry include technology transfer, factory floor training, and job certification programs. Growth of manufacturing in the region has been driven by Augusta's high tech development in electronics, process control, telecommunications, computers, medical services and instrumentation.

Augusta Technical Institute and Center for Advanced Technology (CADTEC)

Augusta Technical Institute (ATI) is part of Georgia's Department of Technical and Adult Education system, serving a large percentage of the two-state Central Savannah River area through its main campus and satellite facilities. The student body includes vocational-technical and college prep students, as well as current workers seeking retraining or skills upgrade; ATI has long emphasized outreach and special attention to the needs of low income, rural and disadvantaged residents, as well as displaced workers, single parents, women in non-traditional fields, and the disabled. In 1983, the Institute used the opportunity to host one of Georgia's new regional advanced technology centers (ATC's) to streamline its technical programs and thereby help to ensure the future employability of its students. ATI's Center for Advanced Technology (CADTEC) is designed to provide technology research and demonstration, industry assessments, technical consulting, and industry-specific contract training for the many established and emerging high tech companies in the Augusta region.

Development Team

- **Project Director:** Mr. Ray Center, Director of CADTEC, served as program director for the MASTER project.
- **Subject Matter Expert**: Ronnie Lambert, MS, MASTER Site Coordinator, had program responsibility for developing skill standards based on the industry skills verification process, as well as developing course curricula and program materials for the MASTER pilot program in Industrial Maintenance Mechanic and Instrumentation Technician. Mr. Lambert has taught Industrial Maintenance Mechanic and Instrumentation for 32 years in colleges and industry across the Southeast.

Introduction:
STUDENT LABORATORY MANUAL

Prior to the development of this Student Laboratory Manual, **MASTER** project staff visited over 150 companies, conducted interviews with over 500 expert workers, and analyzed data from a national survey involving over 2800 participating companies. These investigations led to the development of a series of Instructor Handbooks, with each being fully industry-driven and specific to one of the technologies shown below:

Advanced CNC and CAM
Automated Equipment Repair
Computer Aided Design & Drafting
Conventional Machining
Industrial Maintenance
Instrumentation
LASER Machining
Manufacturing Technology
Mold Making
Tool And Die
Welding

Each Instructor's Handbook contains a collection of Technical Training Modules which are built around a Competency Profile for the specific occupation. **The Competency Profile which is the basis for this Student Laboratory Manual may be found on the following page (and on each of the tab pages in this book).**

This Student Laboratory Manual has been developed as an learning aid for both the instructor and for the student, and is intended to be used in conjunction with the Instructor's Handbook.

This Student Laboratory Manual is arranged by Duty groupings (Duty A, Duty B, etc.) with learning modules available for each Task Box on the Competency Profile.

This Student Laboratory Manual is supplied with an accompanying Instructor's Handbook for use by the instructor.

Each module in the Instructor's Handbook has a corresponding learning module in the Student Laboratory Manual.

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and repair transmitters	C-12 Test different field sensing elements, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Calibrate transmitters	C-15 Tune controllers: pneumatic and electronic	C-16 Trouble-shoot and repair plant computing systems relating to process controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and repair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and configure smart field devices, i.e., transmitters and valves	C-35 Operate control systems including single element, cascade, ratio, and feedforward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Determine proper tools, equipment, and materials to perform the job	D-3 Coordinate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment isolation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibration procedures	D-8 Follow specifications and procedures	D-9 Perform algebraic operations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibration data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise procedures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and dsawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Application of ISA/IEC standards	F-5 Understand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Understand personal computers	F-10 Attend on-going safety training courses	F-11 Participate in plant related training	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and repair transmitters	C-12 Test different field sensing elements, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Calibrate transmitters	C-15 Tune controllers: pneumatic and electronic	C-16 Trouble-shoot and repair plant computing systems relating to process controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and repair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and configure smart field devices, i.e., transmitters and valves	C-35 Operate control systems including single element, cascade, ratio, and feedforward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Determine proper tools, equipment, and materials to perform the job	D-3 Coordinate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment isolation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibration procedures	D-8 Follow specifications and procedures	D-9 Perform algebraic operations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibration data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise procedures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Application of ISA/IEC standards	F-5 Understand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Understand personal computers	F-10 Attend on-going safety training courses	F-11 Participate in plant related training	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

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Duty A

INT-A1-HO
Use Protective Equipment
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objectives:

Upon completion of this module the student will be able to:

a. Identify safety equipment appropriate to protect the eyes from flying particle matter or chemicals;
b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
c. Identify equipment appropriate to protect against high level of noise;
d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,
e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

Reading Assignments:

The following chapters are assigned to read from *Supervisor's Safety Manual* textbook, Latest Edition:

Chapter	Title
7	Controlling Hazards; Protecting the Eyes: Equipment Types, Face Protection, Overcoming Employee Complaints; Protecting the Head: Fabrication, Auxiliary Features, Overcoming Objections; Ear Protection: Amount of Protection, Insert-Type Protectors, Muff Types; Protecting Fingers, Palms, and Hands; Protecting the Torso; Respiratory Protective Equipment: Selecting the Respirator, Overcoming Employee Complaints; Safety Belts and Harnesses: Fabrication, Lifelines, Inspection

and Care of Belts and Lines; Protection Against Ionizing Radiation: Monitoring Radiation; Safe Work Clothing: Materials for Protective Clothing; Clothing for Women, Special Problems Today for Men; "Selling" Personal Protective Equipment: Paying for Protective Equipment.

Module Outline:

I. Describe Types of Conditions That Would Require the Use of Protective Equipment Due to Air Borne Partials
   - A. Grinding operations
   - B. Any time while in an active production environment
   - C. Near welding operations
   - D. Near high pressure water, air, or other medians, i.e., oil
   - E. Possibility of splashing chemicals

II. Identify Condition That Would Require the Use of a Hard Hat
   - A. Generally anytime while in a construction or manufacturing environment
   - B. In areas with low overhead clearances

III. Review Conditions That Would Require Use of Hearing Protection
   - A. Ear plugs
   - B. Ear muffs
   - C. OSHA requirements

IV. Describe Typical Conditions That Would Warrant Use of Gloves to Protect the Hands
   - A. Grinding
   - B. Working with rough metals
   - C. Working with multi strand steel cables
   - D. Electrical (special insulated gloves may be required for certain voltages)

V. Identify How Lungs Are Protected from Harmful Chemicals/particles
   - A. Plant engineering/ventilation
   - B. Use of respirators or bubble suits
   - C. Review OSHA requirements for fiber glass, asbestos and chemical protection

INT-A1-LA
Use Protective Equipment
Attachment 2: **MASTER** Laboratory Aid

Standards of Performance Safety:

Student shall demonstrate safe attitude by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. There will be no horse play or practical joking; and,
2. If in doubt as to safe operation of the equipment, **STOP** and seek guidance from the instructor.

INT-A1-LW
Use Protective Equipment
Attachment 3: **MASTER** Laboratory Worksheet

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1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Ear plugs
   Ear muffs

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercise inserting and removing ear plugs.

5. Practice using ear plugs.

6. Practice exercise using ear muffs.

INT-A2-HO
Accident Prevention
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the two major factors in working safely;
b. List four steps you can take prior to performing work that will insure a safe outcome;
c. Identify the employees responsibility if a potential accident or unsafe condition exist; and,
d. Select specific task that have the potential to cause an injury.

Reading Assignments:

The following chapters are assigned to read from ***Supervisor's Safety Manual*** textbook, Latest Edition:

Chapter	Title
4	Promote Safe Workmanship: Employee Committees, Safety Posters, Special-Purpose Reminders, Off-Beat Ideas, Recognition Organizations, Safety Meetings; Off-the-Job Accident Problems: Cost of Off-the-Job Accident Problems: Cost of Off-the-Job Accidents, Humanitarian Reasons for OTJ Safety Activities, Measuring Accident Experience, Integrating OTJ with On-the-Job Safety Programs, the Supervisor's Role in OTJ Safety.
5	Giving Instructions: Importance of Job Instruction, Starting the New Man; On-the-Job Training: Over-the-Shoulder Coaching; Job Safety Analysis: Select the Job, Break the Job Down, Identify Hazards and Potential Accidents, Develop Solutions, Benefits of JSA; Job Instruction Training: Step 1-Preparations, Step 2-Presentation, Step 3-Application, Step 4-Testing Follow-up; Other Methods of Instruction: The Lesson Plan, Programmed Instruction, Independent Study, Closed-Circuit TV, Summary.

FIRE PREVENTION CHECK LIST

ELECTRICAL EQUIPMENT

- ☐ No make shift wiring
- ☐ Extension cords serviceable
- ☐ Motors and tools free of dirt and grease
- ☐ Lights clear of combustible materials
- ☐ Safest cleaning solvents used
- ☐ Fuse and control boxes clean and closed
- ☐ Circuits properly fused
- ☐ Equipment approved for use in hazardous areas (if required)
- ☐ Ground connection clean and tight

FRICTION

- ☐ Machinery properly lubricated
- ☐ Machinery properly adjusted and aligned

SPECIAL FIRE-HAZARD MATERIALS

- ☐ Special isolation of flammable materials
- ☐ Nonmetal stock free of tramp metal

WELDING AND CUTTING

- ☐ Areas surveyed for fire safety
- ☐ Combustibles removed or covered
- ☐ Permit issued

OPEN FLAMES

- ☐ Kept away form spray rooms and booths
- ☐ Portable torches clear of flammable surfaces
- ☐ No gas leaks

PORTABLE HEATERS

- ☐ Set up with ample horizontal and overhead clearances
- ☐ Secured against tipping or upset
- ☐ Combustibles removed or covered
- ☐ Safely mounted on noncombustible surface
- ☐ Not used as rubbish burners

HOT SURFACES

- ☐ Hot pipes clear of combustible materials
- ☐ Ample clearance around boilers and furnaces
- ☐ Soldering irons kept off combustible surfaces
- ☐ Ashes in metal containers

SMOKING AND MATCHES

- ☐ "No smoking" and "smoking" areas clearly marked
- ☐ Butt containers available and serviceable
- ☐ No discarded smoking materials in prohibited areas

SPONTANEOUS IGNITION

- ☐ Flammable waste material in closed metal containers
- ☐ Flammable waste material containers emptied frequently
- ☐ Piled material cool, dry, and well ventilated
- ☐ Trash receptacles emptied daily

STATIC ELECTRICITY

- ☐ Flammable liquid dispensing vessels grounded or banded
- ☐ Moving machinery grounded
- ☐ Proper humidity maintained

HOUSEKEEPING

- ☐ No accumulations of rubbish
- ☐ Safe storage of flammables
- ☐ Passageways clear of obstacles
- ☐ Premises free of unnecessary combustible materials
- ☐ No leaks or dripping of flammables and floor free of spills
- ☐ Fire doors unblocked and operating freely with fusible links intact

EXTINGUISHING EQUIPMENT

- ☐ Proper type
- ☐ In proper location
- ☐ Unobstructed
- ☐ Clearly marked
- ☐ In working order
- ☐ Service date current
- ☐ Personnel trained in use of equipment

Module Outline:

I. Major Factors in Working Safely
   A. Knowing what the records are
      1. Recognizing when things are not as they should be
   B. Attitude towards safety
      1. A state of mind that requires you to accept responsibility for your own and your coworkers' safety
      2. A state of mind that does not compromise safety for production or speed
      3. A state of mind that would stop production rather than put an employee at unnecessary risk

II. Four Steps That Help Insure a Safe Job
   A. Preparing to do the job
      1. Research task to insure it can be performed
      2. Appropriate tools and help are available
      3. Proper lockout procedure
   B. Select appropriate safety equipment
   C. Once the job starts, maintain a clean work place
   D. Avoid unsafe practices
      1. Failing to use safety equipment
      2. Performing task you are not qualified to perform
      3. Rushing
      4. Practical joking
      5. Making do with a tool rather than getting the right tool

III. Employee Responsibility
   A. Assure responsibility for your own safety
   B. Notify crew and supervision of an unsafe condition
   C. Stop work if unsafe condition is identified

IV. Task That Have the Potential to Cause Injury
   A. Working with electricity
   B. Working near rotating equipment
   C. Working with chemicals and solvents
   D. Using pneumatic or hydraulic equipment
   E. Using ladders
   F. Lifting heavy objects
   G. Working in areas with harmful fumes

INT-A3-HO
Working Aloft
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Describe typical safety equipment used when working aloft;
b. Describe how to set up a portable ladder for use;
c. Define basic safety concerns while working from scaffolding;
d. Identify the safety concerns to be addressed while working from a personal man basket;
e. Demonstrate use of a safety belt/harness; and,
f. Demonstrate proper set up and use of a portable ladder.

Reading Assignments:

The following chapters are assigned to read from textbook:

Chapter	Title
9	Manual Handling Methods; Lifting and Carrying; Equipment for Handling; Hand Trucks, Ropes, Chains and Slings; Fiber Ropes; Rope Slings

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Module Outline:

I. Identify Safety Equipment Used When Working Aloft
Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA

A. Equipment common to most personnel when working aloft
1. Safety glasses
2. Hard hat

3. Safety belt or harness

II. Describe How to Set up a Portable Ladder for Use
   A. Portable ladder are broken down in the CFRs as metal and wood ladders
   B. Wood ladders see 29 CFR 1910.25
      1. Single section ladder
      2. Two section ladder
      3. Special use wood ladders
      4. Step ladder
   C. Metal ladders see 29 CFR 1910.26
   D. Set up 29 CFR 1910.26
      1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall

III. Basic Safety Concerns While Working from Scaffolding

Note: This module does not address scaffolding erection because special training is required

   A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
   B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
   C. Never lean over the handrails to perform work

IV. Concerns While Working from a Man Basket or Personnel Lift
   A. Use basket or lift for employees and tools only, not freight
   B. If basket has integral test weights insure weights are removed prior to lifting personnel
   C. Hands must be inside basket while basket is moving
   D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
   E. Always inspect basket rigging prior to entry
   F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder
   A. Determine wall to base of ladder distance
   B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

INT-A3-LA
Working Aloft
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. If in doubt as to safe operation of the equipment, **STOP** and seek guidance from the instructor.

INT-A3-LW
Working Aloft
Attachment 3: **MASTER** Laboratory Worksheet

I. Identify Safety Equipment Used When Working Aloft
Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA
   A. Equipment common to most personnel when working aloft
      1. Safety glasses
      2. Hard hat
      3. Safety belt or harness

II. Describe How to Set up a Portable Ladder for Use
   A. Portable ladder are broken down in the CFRs as metal and wood ladders
   B. Wood ladders see 29 CFR 1910.25
      1. Single section ladder
      2. Two section ladder
      3. Special use wood ladders
      4. Step ladder
   C. Metal ladders see 29 CFR 1910.26
   D. Set up 29 CFR 1910.26
      1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall

III. Basic Safety Concerns While Working from Scaffolding
Note: This module does not address scaffolding erection because special training is required
   A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire
   B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness
   C. Never lean over the handrails to perform work

IV. Concerns While Working from a Man Basket or Personnel Lift
   A. Use basket or lift for employees and tools only, not freight
   B. If basket has integral test weights insure weights are removed prior to lifting personnel
   C. Hands must be inside basket while basket is moving
   D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline
   E. Always inspect basket rigging prior to entry
   F. Once the basket is in position it must be tied off if egress from the basket is required

V. Demonstrate Proper Set up and Use of an Extension Ladder
   A. Determine wall to base of ladder distance

B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

INT-A4-HO
Fire Safety
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the technicians responsibilities relative to fire safety;
b. List conditions required for fire to exist;
c. Name four classes of fires;
d. List four typical causes of industrial fires described in the lesson;
e. Match the correct class extinguishers to a given fuel source; and,
f. Demonstrate proper use of a fire extinguisher.

Reading Assignments:

The following chapters are assigned to read from textbook.

Chapter	Title
12	Basic Principles; Understanding Fire Chemistry; Determining Fire Hazards; Informing the Working Force; Causes of Fire: Electric Equipment, Friction; Special Fire-Hazard Materials; Welding and Cutting; Open Flames; Portable Heaters; Hot Surfaces; Smoking and Matches; Spontaneous Ignition; Static Electricity; Fire-Safe Housekeeping; Alarms; Equipment; Evacuation; Fire Alarms; What About Extinguishers?; Follow Up for Fire Safety; Fire Brigades; Special Fire Protection Problems

Module Outline:

I. Technician's Responsibility
   A. Each employer will have company specific rules
   B. Unless the technician is part of the company fire fighting crew or fire brigade
      1. Notify every one in the area to evacuate
      2. Get to a phone and notify appropriate department
      3. Something as simple as an ash tray or trash can can start fire that may be easily and safely extinguished. Appropriate department must be notified of the event
      4. Employees are responsible for keeping the workplace safe and for reporting unsafe conditions

II. Identify Conditions Required for a Fire to Exist
   A. Fuel
   B. Oxygen
   C. Heat

III. Four Classes of Fire
   A. Ordinary combustibles
   B. Flammable liquids
   C. Electrical
   D. Combustible metals

IV. List Four Typical Causes of Workplace Fires
   A. Careless smokers
   B. Electrical overloads
   C. Inadequate fire watch for welding and cutting operations
   D. Combustible dust in the atmosphere

V. Demonstrate to Class How to Match the Correct Extinguishers for the Class of Fire

VI. Demonstrate Proper Use of a Fire Extinguisher

Fire Extinguisher
Agent Characteristics

Suitable for use on what type of fire: B C

Agent Characteristics:
- Regular or Ordinary Dry Chemical
- Basically Sodium Bicarbonate
- Discharges a white cloud
- Leaves residue
- Non-freezing

Average Size - 1 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: ABC or BC

Agent Characteristics:
- Multipurpose Dry Chemical
- Basically Ammonium Phosphate
- Discharges a yellow cloud
- Leaves residue
- Non-freezing
- Some extinguishers utilizing this agent do not have an "A" rating; however, they are designated as having "A" capability.

Average Size - 2 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- Purple-K Dry Chemical
- Basically Potassium Bicarbonate
- Discharges a bluish cloud
- Leaves residue
- Non-freezing

Average Size - 2 to 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 8 to 25 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- KCL Dry Chemical
- Basically Potassium Chloride
- Discharges a white cloud
- Leaves residue
- Non-freezing
- Potassium Chloride/Urea

Average Size - 2 to 30 lbs. (11 to 23)
Horizontal Range - 5 to 20 ft. (15 to 30)
Discharge Time - 8 to 25 sec. (20 to 31)

Suitable for use on what type of fire: B C

Agent Characteristics:
- Carbon Dioxide
- Basically an inert gas that discharges a cold white cloud
- Leaves no residue
- Non-freezing

Average Size - 2 ½ to 20 lbs.
Horizontal Range - 3 to 8 ft.
Discharge Time - 8 to 30 sec.

Suitable for use on what type of fire: B C

Agent Characteristics:
- Halogenated Agent
- Basically halogenated hydrocarbons
- Discharges a white vapor
- Leaves no residue
- Non-freezing

Average Size - 2 ½ lbs.
Horizontal Range - 4 to 8 ft.
Discharge Time - 8 to 10 sec.

Suitable for use on what type of fire: A

Agent Characteristics:
- Water
- Basically tap water
- Discharges in a solid or spray stream
- May contain corrosion inhibitor which leaves a yellow residue
- Protect from freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: A

Agent Characteristics:
- Anti-Freeze Solution
- Basically a Calcium Chloride solution to prevent freezing
- Discharges a solid or spray stream
- Leaves residue
- Non freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: A B

Agent Characteristics:
- Loaded Stream
- Basically an alkali-metal-salt solution to prevent freezing
- Discharges a solid or spray stream
- Leaves residue
- Non freezing

Average Size - 2 ½ gal.
Horizontal Range - 30 to 40 ft.
Discharge Time - 1 minute

Suitable for use on what type of fire: B

Agent Characteristics:
- Foam
- Basically a water and detergent
- Discharges a foamy solution
- After evaporation, leaves a powder residue
- Protect from freezing

Average Size - 18 oz.
Horizontal Range - 10 to 15 ft.
Discharge Time - 24 sec.

Suitable for use on what type of fire: D

Agent Characteristics:
- Dry Powder Special Compound
- Basically Sodium Chloride or Graphite materials
- Agent is discharged from an extinguisher in a solid stream or is applied with a scoop or shovel to smother combustible metal
- Leaves residue
- Non-freezing

Average Size - 30 lbs.
Horizontal Range - 5 to 20 ft.
Discharge Time - 25 to 30 sec.

INT-A4-LA
Fire Safety
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Conduct:

1. If in doubt as to safe operation of the equipment, **STOP** and seek guidance from the instructor.

INT-A4-LW
Fire Safety
Attachment 3: **MASTER** Laboratory Worksheet

Standard of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Worksheet:

1. Established standards for safety and conduct shall be followed

2. Equipment required:
   Dust Mask;
   Gloves;
   Fire extinguishers;
   Face shield; and,
   Side shields.

3. Instructor must confirm proficiency prior to student progressing

4. Practice exercises
   A. Instructor will demonstrate proper usage of fire extinguishers
   B. Student shall practice using fire extinguishers

INT-A5-HO
Lifting Safety
Attachment 1: **MASTER** Handout

Standards pf performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face-shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify the consequences of improper lifting techniques;
b. Recognize when it is unsafe to lift an object alone;
c. Demonstrate proper lifting techniques;
d. Identify safety concerns to be addressed when lifting rough, sharp or fragile items;
e. State formula for dealing with center of gravity;
f. Identify parts of hoist;
g. Safely demonstrate using a hoist; and,
h. Move a load using a hoist.

Reading Assignments:

The following chapters are assigned to read from ***Supervisor's Safety Manual*** textbook, Latest Edition:

Chapter	Title
9	Material Handling Problems; Manual Handling Methods; Lifting and Carrying; Handling Specific Shapes; Equipment for Handling; Hand Trucks; Powered Hand Trucks; Powered Industrial Trucks; Conveyors; Chains and Slings

The following chapters are assigned to read from ***Mechanics' and Millwrights' Guide,*** Carl Nelson, Audel Publishers, Latest Edition:

Chapter	Title
21	Rigging

Module Outline:

I. Discuss the Importance of Lifting Safely
   A. Give each student a copy of the following attachments:
      1. Laboratory Aid
      2. Objectives, Reading Assignments, and Module Outline
      3. Laboratory Worksheet
II. Identify the Steps to Manually Lift Safely
   A. Estimate the load to be lifted. If it is heavier than one person should attempt, get help.
   B. Place feet properly. Spread your feet slightly (comfortably), with one foot slightly ahead of the other and alongside the object.
   C. Bend knees, kneel, or squat. Get close enough to the load to reach under it without bending the back.
   D. Use blocking under objects to get a handhold and to prevent crushed fingers.
   E. Get a good grip. Be sure you can maintain your grip on the object. Use gloves when handling sharp or rough objects.
   F. Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting.
   G. Do not turn the body at the waist while carrying a load.
   H. Lower the load to the floor from the carrying position by bending the knees while keeping the back straight. This keeps the load on the leg and arm muscles. Keep fingers and toes clear as the load is set.
III. Consequences of Improper Lifting
   A. Injury
   B. Loss time
   C. Possibility of becoming unemployed
IV. When Is It Unsafe to Lift an Object Alone
   A. Bulked load that restricts view
   B. When you would have to lift with your back rather than your legs
   C. When the object is too large to get a good grip
V. Discuss Handling Specific Shapes
   A. Locate center of gravity and use this area to lift
   B. Place as much weight as possible as close to lifting mechanism
   C. Place flat weight on button
VI. Safety Concerns When Lifting Rough, Sharp, or Fragile Objects
   A. Gloves
   B. Safety glasses
   C. Is the object being lifted a hazardous material?
VII. Discuss Equipment for Material Handling

A. Hand trucks
B. Powered trucks
C. Conveyers
D. Hoists

VIII. Discuss and Demonstrate Safe Use of Hand Trucks
A. Place most of the weight on bed of hand truck
B. May require two people if one object is difficult to lift on side
C. Hold object tightly as handle is pulled back
D. Adjust handle position so more weight is on hand end
E. After movement, hold object tightly as handle is moved upward
F. Lift object on one side so bed of truck can be moved away from object

IX. Discuss and Demonstrate Use of Powered Hand Trucks
A. Watch out for people
B. Drive unit slowly
C. Use manual lifting rules

X. Discuss and Demonstrate Safe Use of Conveyers
A. Watch for pinch points
B. Exercise caution when loading and unloading objects
C. Do not overload conveyers. Rollers may not move freely

XI. Discuss and Demonstrate Safe Use of Hoists
A. Formula for dealing with center of gravity
B. Identify parts of hoist
C. Safely demonstrate using a hoist
D. Identify types of loads
E. Discuss and demonstrate lifting techniques
F. Discuss and demonstrate moving techniques

XII. Discuss and Demonstrate Safe Use of Chains and Slings
A. Storage area should be clean and dry
B. Watch for pinch points
C. Inspect for defects before using:
1. Chains
a. Wear
b. Stretch
c. Distortion
d. Nicks
e. Cracks
f. Gauges
2. Slings
a. Wear
b. Stretch
c. Distortion
d. Flat, Sling Spots

D. Types
1. Slings
a. Choker

b. Double Choker
c. Bridle
d. Basket
e. Double Basket

INT-A5-LA
Lifting Safety
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horseplay or practical joking.

Conduct:

1. There will be no horse play or practical joking.
2. If in doubt as to safe operation of the equipment, **STOP** and seek guidance from the instructor.

INT-A5-LW
Lifting Safety
Attachment 3: **MASTER** Laboratory Worksheet

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Worksheet:

1. Established standards for safety and conduct shall be followed.
2. Equipment required:
   Hand truck
   Conveyor
   Chains
   Sling
   Face shield
   Side shields
3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student's progressing to next exercise.
4. Practice manual lifting.
5. Practice using hand truck to carry objects.
6. Practice using powered truck to carry objects.
7. Practice using hoist to move objects.
8. Practice handling specific shapes.
9. Practice lifting with slings.
10. Practice lifting with chains.
11. Instructor will guide each exercise.
12. Instructor will grade each exercise.

INT-A6-HO
Lockout/Tagout
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Recognize the benefits of an effective lockout/tagout procedure;
b. Identify who is allowed to remove or install a lockout/tagout tag or lock;
c. Recognize who is responsible for assuring equipment is properly locked out or tagged-out prior to performing maintenance; and,
d. Determine if all emergency condition are cleared for maintenance.

Module Outline:

I. Benefits of an Effective Lockout/Tagout Program
   A. Reduce employee injuries and death
   B. Reduce down time
   C. Increased awareness pf employees role in insuring safety in the work environment
   D. Less regulatory involvement
   E. Review 29 CFR 1910.147
II. Who May Hang, Remove a Lockout or Tagout Tag or Lock
   A. Identify when a lockout is needed
   B. Identify when a tagout is appropriate. This will also vary between industry clearance procedures.
III. Responsibility for Lockout/Tagout
   A. Typically it is the work crew leader who is also responsible for briefing the crew as to the clearance boundaries and what is locked out
   B. Carefully loosen a flange and break the seal (never remove the bolts). Only loosen slightly.

C. Open system relief valve

IV. Locking out or Clearing a Piping, Mechanical System or Component for Maintenance

A. Identify typical sources of force that may be present in a typical piping system
   1. Static head pressure or induced thermal pressure
   2. Incline accumulators
   3. Unisolated automatic actuating valves, motors or relief
   4. System pressure
   5. Stress that any or all of these forces have the ability to injure or kill is not properly cleared lockout and depressurized prior to maintenance

B. Methods of relieving trapped pressure from a system or component
   1. Vent and drain valves
   2. Carefully loosen a flange and break the seal (never remove the bolts). Only loosen slightly.
   3. Open system relief valve

C. Identify typical methods of disabling components prior to maintenance
   1. Manual operated valves
   2. Pneumatic operated valves (fail open or closed)
   3. Hydraulic actuated valve
   4. Relief valves
   5. Fans
   6. Rollers

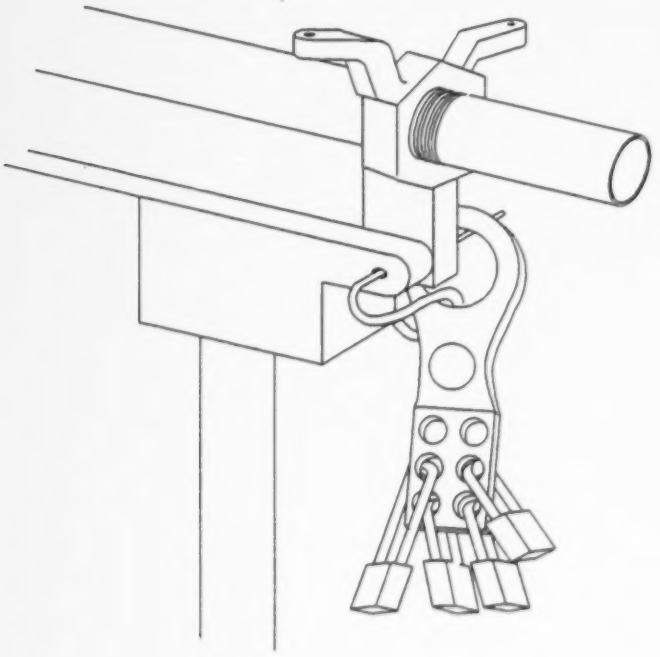
Reading Assignments:

Read the handout titled "Lockout and Tagout Procedures."

Lockout and Tagout Procedures

Lockout and tagout procedures are designed to prevent equipment from being energized while maintenance is taking place. The types and uses are defined by the Occupational Safety and Health Administration, CFR 1910.147.

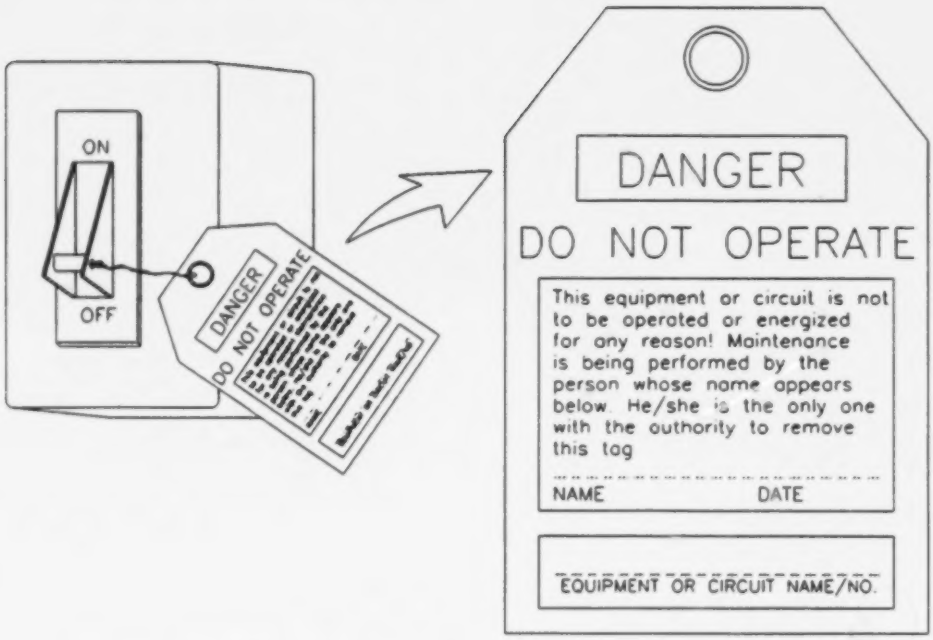
To lockout is to place a locking device on an energy-isolating device — a manually operated circuit breaker, for instance. The energy-isolating device and the equipment being controlled cannot be operated until the lockout device is removed. See Figure 1.



1 - A Lockout Device

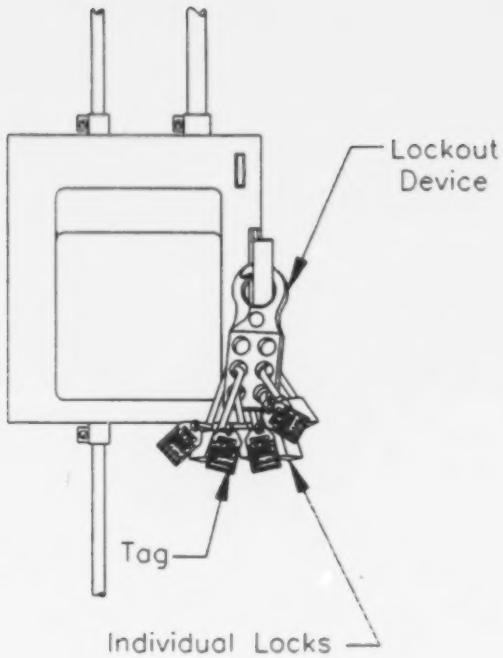
Remote or interlocking switches may not be used to control circuits. The use of emergency stops are prohibited for lockout-tagout by OSHA. They do not offer positive protection.

Tagouts are placed on an energy-isolating device. They indicate that the energy-isolating device and the equipment being controlled may not be operated. Tagouts are red and have black lettering. A tag must be signed and dated by the individual who placed it. OSHA has two additional requirements for these tags. The purpose of the lockout/tagout (the procedure performed) must be written on the tag. Most companies put this information on the back of a tag. See Figure 2.


ON
OFF
DANGER
DO NOT OPERATE
DANGER
DO NOT OPERATE
This equipment or circuit is not to be operated or energized for any reason! Maintenance is being performed by the person whose name appears below. He/she is the only one with the authority to remove this tag
NAME
DATE
EQUIPMENT OR CIRCUIT NAME/NO.

2 - Tagout

When more than one person is involved, each individual must place a lockout/tagout device on the isolation device. If a lockout device is used, it should be capable of accepting multiple locks. This is so each individual can place a lock on the device. Each lock should have a tag similar to the one used in the tagout procedure. The individual who puts the lock in place signs the tag. See Figure 3.



3 - Multiple-Lock Lockout Device

The lockout physically prohibits the operation of a piece of equipment. The tagout relies on those who read it. They must recognize its significance.

Wherever lockout/tagouts are used, there must be an established procedure for all to follow. All personnel must understand the importance and the use of the lockout/tagout system. The lockout/tagout devices used within an organization are standardized. So, anyone within the organization will recognize what they are.

The restrictions indicated by lockouts and tagouts remain in force until they are removed. The person putting the tagout or lockout in place is the person who has the authority to remove it.

The Occupational Safety and Health Act sets standards that are administered by the Occupational Safety and Health Administration (OSHA). OSHA has standard lockout/tagout procedures. The lockout/tagout procedures apply to all energy systems — air, hydraulic, mechanical, and electrical.

Zero-Energy Concept

Your job may be to maintain electrical circuits and equipment. However, many of them are connected to mechanical, hydraulic, or pneumatic devices. So, the equipment you work on may involve other types of energy in addition to electricity. Zero energy means all forms of energy are neutralized.

There may be hydraulic or pneumatic pressure in hoses or lines. There may be stored energy in weights or springs. There may be the potential for movement, as when air might blow through a turbine or fan. All these forms of energy must be recognized and neutralized. They have the potential to injure you or damage equipment.

Before working on any type of equipment, release or neutralize all energy which might affect that equipment. This means taking whatever action is necessary — turning a valve or putting a jack under a weight, for instance. This is the zero-energy concept.

Standards of performance safety:

Student shall demonstrate safe work habits in the work shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-A6-LW
Lockout/Tagout
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. The project will require the student to demonstrate skills and knowledge in the following:
   A. Practice safety
   B. Use approved eye protection.
   C. Remove energy source
   D. Place tag
   E. Place lock
   F. Sign tag
   G. Remove lock
   H. Remove tag

2. Established standards for safety and conduct shall be followed.

3. Equipment required:
   A. Lock
   B. Tag
   C. Safety Switch

4. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

5. Practice exercises:
   A. Use lock to lock energy supply. Instructor must demonstrate placing lock on energy supply.
   B. Use tag to tag energy supply. Instructor must demonstrate placing tag on energy supply.

6. Practice exercise:
   A. Student shall practice placing tag on energy source.
   B. Student shall practice placing lock on energy source.

INT-A7-HO
Use Electrical Equipment
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safety knowledge when working with electrical devices by:
Observing all safety rules in lab;
Not touching an energized electrical circuit;
Exercising extreme caution in dealing with an electrical circuit; and,
Using electrically tested gloves and proper by calibrated test equipment when working with electricity.

Objectives:

Upon completion of this module the student will be able to:

a. State the differences in current levels of electrical shock and their effect on the body;
b. Compare electrical resistance between specified parts of the human body;
c. Explain safety benefits of good workplace housekeeping;
d. Summarize your company's policy for testing of meters;
e. Select the protective equipment you should use when working with operating electricity;
f. Explain the purpose and operation of a ground fault circuit interrupter (GFCI); and,
g. State the purpose of the Occupational Safety and Health Act.
h. State your company's policy on the two-man rule.

PHYSIOLOGICAL EFFECTS OF ELECTRIC CURRENTS		
Readings		**Effects**
Safe Current Values	1 mA or less	Causes no sensation - not felt.
	1 mA to 8 mA	Sensation of shock, not painful. Individual can let go at will since muscular control is not lost
Unsafe Current Values	8 to 15 mA	Painful shock - individual can let go at will since muscular control is not lost.
	15 to 20 mA	Painful shock - control of adjacent muscles lost. Victim cannot let go.
	20 to 50 mA	Painful, severe muscular contractions. Breathing difficult.
	50 to 100 mA	Ventricular fibrillation - a heart condition that can result in instant death - is *possible*.
	100 to 200 mA	Ventricular fibrillation occurs.
	200 mA and over	Severe burns, severe muscular contractions - so severe that chest muscles clamp the heart and stop it for the duration of the shock.

HUMAN RESISTANCE TO ELECTRICAL CURRENT	
	Resistance (Ohms)
Dry skin	100,000 to 600,000
Wet skin	1,000
Internal body - hand to foot	400 to 600
Ear to ear	100

Reading Assignments:

The following chapters are assigned to read from the *National Electrical Code* (NEC), NFPA 70, Batterymarch Park, Quincy, MA 02269:

Chapter	Title
1	Introduction, General
2	Wiring and Protection
3	Wiring Methods & Materials
4	Equipment for General Use
5	Special Occupancies
6	Special Equipment
7	Special Conditions
8	Communications Systems

Note: Above reading assignments in the NEC should translate into familiarity with the NEC.

The following chapters are assigned to read from *Supervisor's Safety Manual* textbook, Latest Edition:

Chapter	Title
2	See and Know Job Hazards
	Systematic Inspection
	Unsafe Conditions and Unsafe Acts

Module Outline:

I. Electric Shock
   - A. Voltage level
   - B. Current level
   - C. One hand rule

II. Electrical Resistance
   - A. Body resistance
   - B. Current path
   - C. Ohm's Law

III. Electrical Test Meters
   - A. Ohmmeter
   - B. Voltmeter
   - C. Ammeter

IV. Tools
   - A. Ladders
   - B. Electrical hand tools
   - C. Tool condition

V. Protective Equipment
   A. Multimeter
   B. Electrical gloves
   C. Electrical hand tools
VI. Ground Fault Circuit Interrupter (GFCI)
   A. NEC requirements
   B. How GFCI works
   C. GFCI format
VII. Environmental
   A. Housekeeping
   B. Safety attitude
   C. Clean spills quickly
   D. Grounding
VIII. Occupational Safety and Health Act
   A. Purpose to OSHA
   B. 29 CFR 1910
IX. Two Man Rule
   A. Buddy system
   B. Second person's responsibility
X. Guarding
   A. Safe distance from live circuits
   B. NEC 110-10, 240-41, 430-14, 511-7, 513-5, 514-4, 515-4, 516-7, 517
   C. 29 CFR 1910.331 through 29 CFR 1910.335

Standards of performance safety:

Student shall demonstrate safety knowledge when working with electrical devices by:
Observing all safety rules in lab;
Not touching an energized electrical circuit;
Exercising extreme caution in dealing with an electrical circuit; and,
Using electrically tested gloves and proper by calibrated test equipment when working with electricity.

INT-A7-LW
Use Electrical Equipment
Attachment 3: **MASTER** Laboratory Worksheet

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1. Practice using ohmmeter to measure resistors. Instructor will finish ohmmeter and resistors. Calibrate meter before using.

2. Practice using voltmeter to measure voltages. Instructor will furnish voltmeter. Calibrate meter before using.

3. Practice using ammeter to measure current. Calibrate meter before using.

4. Instructor will demonstrate proper use of electrical hand tools and electrical gloves.

5. Instructor will discuss ladders and electricity.

6. Instructor will demonstrate safety harness usage.

7. Instructor will discuss GFCI's.

8. Instructor will discuss housekeeping, safety attitude, and grounding, electric shock, OSHA, buddy system, and proper clearance from live circuits.

9. Instructor will discuss extension cord inspection and usage.

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and repair transmitters	C-12 Test different field sensing elements, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Calibrate transmitters	C-15 Tune controllers: pneumatic and electronic	C-16 Trouble-shoot and repair plant computing systems relating to process controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and repair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and configure smart field devices, i.e., transmitters and valves	C-35 Operate control systems including single element, cascade, ratio, and feedforeward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Determine proper tools, equipment, and materials to perform the job	D-3 Coordinate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment isolation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibration procedures	D-8 Follow specifications and procedures	D-9 Perform algebraic operations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibration data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise procedures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Application of ISA/JIC standards	F-5 Understand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Understand personal computers	F-10 Attend on-going safety training courses	F-11 Participate in plant related training	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

INT-B1-HO
Proper Storage of Circuit Boards
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate proper storage of circuit boards;
b. Demonstrate proper handling of circuit boards;
c. Use anti-static bags to shield printed circuit boards;
d. Exercise caution when handling a thermally hot printed circuit board; and,
e. Exercise caution when handling an electrically hot printed circuit board.

Module Outline:

I. Purpose of Printed Circuit Boards
II. Composition of Printed Circuit Boards
III. Wire used on Printed Circuit Boards
IV. Terminals used with Printed Circuit Boards
V. Layout of Printed Circuit Boards
VI. Thermal Considerations of Printed Circuit Boards
VII. Electrical Voltage on Printed Circuit Boards
VIII. Shielded Bag for Printed Circuit Board Protection

INT-B1-LA
Proper Storage of Circuit Boards
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B1-LW

Proper Storage of Circuit Boards

Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

Instructor will demonstrate:

a. Proper handling of circuit boards; and,
b. Proper storage of circuit boards.

Student will demonstrate:

a. Proper handling of circuit boards; and,
b. Proper storage of circuit boards.

Instructor will grade student on:

a. Proper handling of circuit boards; and,
b. Proper storage of circuit boards.

INT-B2-HO
Collect and Record Data According to Company Requirements
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate collecting data according company requirements; and,
b. Demonstrate recording data according to company requirements.

Module Outline:

I. Using a P&ID (Process Control) Diagram and a Technical Manual for a Pressure Transducer (Or Some Other Process Measuring Device), Generate the Following:
   A. PM record
   B. Calibration record
   C. Troubleshooting record
   D. Repair record
   E. Replacement record

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B2-LW
Collect and Record Data According to Company Requirements
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how a technical manual and a P&ID diagram for a control device can be used to generate the following:
   a. PM record;
   b. Calibration record;
   c. Troubleshooting record;
   d. Repair record; and,
   e. Replacement record.

2. Student will demonstrate how a technical manual and a P&ID diagram for a control device can be used to generate the following:
   a. PM record;
   b. Calibration record;
   c. Troubleshooting record;
   d. Repair record; and,
   e. Replacement record.

3. Instructor will grade this activity.

INT-B3-HO
Test and Calibrate Transducers According to Specs
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test transducers according to specifications; and,
b. Calibrate transducers according to specifications.

Reading Assignments:

Manufacturer's technical manual concerning testing and calibration procedure and values to expect.

Module Outline:

I. Manufacturer's Technical and Servicing Manual
II. Testing and Calibration Records
III. Field Agreement for Transducer Removal from Service for Testing and Calibration
IV. Tools and Process Flow Diagram
V. Transducer Preparation for Testing
VI. Controller Setting
VII. Remove the Integral and Rate Control Actions While Placing the Proportional Band Setting at 100%
VIII. Remove Transducer from Service
IX. Test and Calibrate Transducer
X. Transducer Placed Back into Service
XI. Record Findings

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B3-LW
Test and Calibrate Transducers According to Specs
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

Use the following steps to perform testing and calibrate transducer.

a. Manufacturer's technical and servicing manual;
b. Testing and calibration records;
c. Climate for transducer removal from service for testing and calibration;
d. Tools and process flow diagram;
e. Transducer preparation for testing;
f. Controller setting;
g. Remove the integral and rate control actions while placing the proportional band setting at 100%;
h. Remove transducer from service;
i. Test and calibrate transducer;
j. Transducer placed back into service; and,
k. Record findings.

Instructor will demonstrate. Student will perform similar activity. Instructor will grade student on this activity.

INT-B4-HO

Perform Preventive Maintenance Procedures for Control Devices

Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Safely perform preventative maintenance procedures for control device;
b. Perform inspection;
c. Perform cleaning;
d. Perform testing;
e. Perform adjusting; and,
f. Perform replacement.

Module Outline:

I. Good Programs Pay off
   A. Fewer breakdowns
   B. Fewer emergencies
   C. More efficient work plans
   D. Less overtime
   E. Longer equipment life
   F. Equitable use of manpower
   G. Increased production/decreased downtime
   H. Cuts in maintenance costs
II. Costs Cut Dramatically
III. Inspections
   A. Causes of equipment breakdown
   B. Predictive maintenance
   C. Previous inspections results
   D. Operator problems

E. Corrective action plans

IV. Establishing Maintenance Routes

V. Steps in Planning
   A. Review
   B. Decide
   C. Implement

VI. Review
   A. Goals and objectives
   B. Job orders and PM inspection reports
   C. Potential problems
   D. Equipment needs
   E. Available resources
   F. Operational budget/needs
   G. Management changes
   H. Priorities assessment

VII. Decision-Making
   A. Assign priorities
   B. Project manpower requirements
   C. Estimate materials and equipment needs
   D. Coordinate PM by objectives
   E. Establish an effective communications system
   F. Monitor costs to budget
   G. Evaluate opportunities
   I. Identify Potential Problems

VIII. Implement
   A. Assign priorities to maintenance projects
   B. Identify major jobs
   C. Assign manpower to jobs
   D. Budget to actual expenses variances
   E. List potential problems
   F. Review and evaluate progress of PM

IX. Maintenance Job Orders (MJO)

X. Priorities
   A. Emergency work to be completed
   B. Two-week maintenance requirements
   C. Four-week routine maintenance
   D. Eight-week maintenance job requirements
   E. Deferred maintenance vs. manpower availability

XI. Scheduling
   A. Short-term scheduling
   B. Long-range scheduling

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B4-LW
Perform Preventive Maintenance Procedures for Control Devices
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will perform preventive maintenance procedures on control device.

2. Student will practice performing preventive maintenance procedures on control device.

3. Instructor will grade student performing prevention maintenance procedures on control devices.

INT-B5-HO
Test and/or Replace Printed Circuit Boards
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test printed circuit boards; and,
b. Replace printed circuit boards.

Module Outline:

I. Printed Circuit Board Terminals
II. Test Points on Printed Circuit Boards
III. Desoldering and Soldering Techniques and Tools Used with Printed Circuit Boards
IV. Heat Sinks
V. IC Sockets
VI. Insulated Long Nose Pliers Usage
VII. Diagonal Cutting Pliers Usage
VIII. Single Sided Boards
IX. Double Sided Boards

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B5-LW
Test and/or Replace Printed Circuit Boards
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Instructor will demonstrate how to test a printed circuit board.
2. Instructor will identify test points.
3. Instructor will identify terminals.
4. Instructor will use desoldering equipment safely to desolder electronic component.
5. Instructor will use soldering equipment safely to solder electronic component.
6. Instructor will use diagonal pliers to cut wires on circuit board.
7. Instructor will use long nose pliers to handle electronic components on circuit board.
8. Student will demonstrate how to test a printed circuit board.
9. Student will identify test points.
10. Student will identify terminals.
11. Student will use desoldering equipment safely to desolder electronic component.
12. Student will use soldering equipment safely to solder electronic component.
13. Student will use diagonal pliers to cut wires on circuit board.
14. Student will use long nose pliers to handle electronic components on circuit board.
15. Instructor will grade each activity performed by the student.

INT-B6-HO
Function Check Individual Elements Within Loop
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to function check individual elements within loop, such as:

a. Transducer;
b. Load cell;
c. Level control;
d. Flow control;
e. Temperature control;
f. Pressure control; and,
g. LVDT.

Module Outline:

I. Transducer
II. Load Cell
III. Level Control
IV. Flow Control
V. Temperature Control
VI. Pressure Control
VII. LVDT

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B6-LW
Function Check Individual Elements Within Loop
Attachment 3: **MASTER** Laboratory Worksheet

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1. Student will practice function checking individual elements within loop:
   a. Transducer;
   b. Load cell;
   c. Level control;
   d. Flow control;
   e. Temperature control;
   f. Pressure control; and,
   g. LVDT.

2. Instructor will grade student's performance in these projects.

INT-B7-HO
Troubleshoot Different Types of System Modules
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Properly use preliminary procedures for troubleshooting;
b. Attack problems in a logical manner;
c. Use vendor manuals;
d. Use troubleshooting tools; and,
e. Troubleshoot different types of system modules.

Module Outline:

I. Preliminary Procedures
II. Logical Techniques
III. Vendor Manual Troubleshooting Guides
IV. Troubleshooting Tools
V. Troubleshooting Procedures

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B7-LW
Troubleshoot Different Types of System Modules
Attachment 3: **MASTER** Laboratory Worksheet

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1. Student will practice using system modules by:
   a. Properly using preliminary procedures for troubleshooting;
   b. Attacking problems in a logical manner;
   c. Using vendor manuals;
   d. Using troubleshooting tools; and,
   e. Troubleshooting different types of system modules.

2. Instructor will grade student's ability to troubleshoot.

INT-B8-HO
Test Different Types of Systems Modules
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Test hermetically sealed module;
b. Test single sided PCB module;
c. Test double sided PCB module;
d. Properly handle heat sinks; and,
e. Use common electronic test equipment.

Module Outline:

I. Single Sided PCB Module
II. Double Sided PCB Module
III. Operate Electronic Test Equipment To Test Module
IV. Test Single Sided PCB Modules
V. Test Double Sided PCB Modules
VI. Test Hermetically Sealed Module

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Instructor will grade student's ability to :

a. Test hermetically sealed module;
b. Test single sided PCB module;
c. Test double sided PCB module;
d. Properly handle heat sinks; and,
e. Use common electronic test equipment.

INT-B9-HO
Configure Software
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the computer lab by not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. List major parts of computer;
b. Demonstrate a working knowledge of keyboard;
c. Demonstrate a working knowledge of DOS;
d. Demonstrate a working knowledge of Windows 3.1;
e. Demonstrate a working knowledge of Windows 95.;
f. Demonstrate a basic knowledge of a word processing software;
g. Demonstrate a basic knowledge of a spreadsheet software;
h. Demonstrate a basic knowledge of a graphic software; and,
i. Demonstrate a basic knowledge of a programming language.

Module Outline:

I. Major Parts of Digital and Analog Computer
II. Keyboard Skills
III. DOS
IV. Windows 3.1
V. Windows 95
VI. Word Processing Software
VII. Spreadsheet Software
VIII. Graphic Software
IX. Computer Languages - Overview

INT-B9-LW
Configure Software
Attachment 2: **MASTER** Laboratory Worksheet

The student shall:

1. Practice booting up a computer;
2. Practice properly powering down computer;
3. Practice using DOS commands;
4. Practice using Windows 3.1;
5. Practice using Windows 95;
6. Practice using a word processing software;
7. Practice using a spreadsheet software;
8. Practice using a graphic software; and,
9. Practice using a programming language.

INT-B10-HO
Repair Different Types of System Modules
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate how to properly use common electronic hand tools;
b. Demonstrate how to remove and replace integrated circuits;
c. Demonstrate how to remove and replace discrete electronic components;
d. Demonstrate how to use power hand tools; and,
e. Demonstrate how to repair system module.

Module Outline:

I. Electronic Hand Tools
II. Electronic Components
    A. Discrete Components
    B. Integrated Circuits
III. Electronic Power Hand Tools
IV. Module Description

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B10-LW

Repair Different Types of System Modules

Attachment 3: **MASTER** Laboratory Worksheet

1, Instructor will:
   a. Demonstrate how to properly use common electronic hand tools;
   b. Demonstrate how to remove and replace integrated circuits;
   c. Demonstrate how to remove and replace discrete electronic components;
   d. Demonstrate how to use power hand tools; and,
   e. Demonstrate how to repair system module.

2. Student will:
   a. Demonstrate how to properly use common electronic hand tools;
   b. Demonstrate how to remove and replace integrated circuits;
   c. Demonstrate how to remove and replace discrete electronic components;
   d. Demonstrate how to use power hand tools; and,
   e. Demonstrate how to repair system module.

3. Instructor will grade practical projects.

INT-B11-HO
Install Control System Hardware
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Install control system hardware;
b. Proper use of common electrical hand tools;
c. Proper use of common electronic hand tools;
d. Proper use of wrist straps;
e. Proper use of common electrical test equipment;
f. Demonstrate correct handling of printed circuit boards; and,
g. Demonstrate proper handling of static sensitive electronic components.

Module Outline:

I. Install Control System Hardware
II. Proper Use of Common Electrical Hand Tools
III. Proper Use of Common Electronic Hand Tools
IV. Proper Use of Wrist Straps
V. Proper Use of Common Electrical Test Equipment
VI. Demonstrate Current Handling of Printed Circuit Boards
VII. Demonstrate Proper Handling of Static Sensitive Electronic Components

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment;
Not participating in horse play or practical joking; and,
If in doubt as to safe operation of the equipment, **STOP** and seek guidance from the instructor.

INT-B11-LW
Install Control System Hardware
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor should demonstrate how to:
   a. Install control system hardware;
   b. Properly use common electrical hand tools;
   c. Properly use common electronic hand tools;
   d. Properly use wrist straps;
   e. Properly use common electrical test equipment;
   f. Demonstrate current handling of printed circuit boards; and,
   g. Demonstrate proper handling of static sensitive electronic components.

2. Student shall demonstrate how to:
   a. Install control system hardware;
   b. Properly use common electrical hand tools;
   c. Properly use common electronic hand tools;
   d. Properly use wrist straps;
   e. Properly use common electrical test equipment;
   f. Demonstrate current handling of printed circuit boards; and,
   g. Demonstrate proper handling of static sensitive electronic components.

3. Instructor will grade student's lab work.

INT-B12-HO
Simulate Control System Check
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Simulate control system check;
b. Build control system; and,
c. Use calibration sheet to identify control system components.

Module Outline:

I. Control System Definition
II. Control System Components
III. Simulation Definition
IV. Control System Check

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B12-LW

Simulate Control System Check

Attachment 3: **MASTER** Laboratory Worksheet

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1. Student will practice:
   a. Simulating control system check;
   b. Building control system; and,
   c. Using calibration sheet to identify control system components.

2. Instructor will grade student's ability to perform simulation of control system.

INT-B13-HO
Look Check Control System
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Identify loops;
b. Describe basic loop components; and,
c. Describe how loop functions.

Module Outline:

I. Loop Definition
II. Loop Components
III. Loop Check Control System Procedures

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B13-LW
Look Check Control System
Attachment 3: **MASTER** Laboratory Worksheet

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1. Student will loop check control system.

2. Instructor will grade student's ability to loop check a control system.

INT-B14-HO
Perform On-Line Testing
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Perform on-line testing;
b. Demonstrate familiarity with simple loops;
c. Demonstrate familiarity with multiple loops;
d. Demonstrate familiarity with DCS system;
e. Demonstrate safety precautions associated with on-line testing; and,
f. Demonstrate using PLC on-line testing features.

Module Outline:

I. Single Loop
II. Multi-Loop
III. PLC-On-Line Features
IV. DCS Systems-On-Line

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-B14-LW
Perform On-Line Testing
Attachment 3: **MASTER** Laboratory Worksheet

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1. Student will:
   a. Perform on-line testing;
   b. Demonstrate familiarity with simple loops;
   c. Demonstrate familiarity with multiple loops;
   d. Demonstrate familiarity with DCS system;
   e. Demonstrate safety precautions associated with on-line testing; and,
   f. Demonstrate using PLC on-line testing features.

2. Instructor will grade the student's ability to:
   a. Perform on-line testing;
   b. Demonstrate familiarity with simple loops;
   c. Demonstrate familiarity with multiple loops;
   d. Demonstrate familiarity with DCS system;
   e. Demonstrate safety precautions associated with on-line testing; and,
   f. Demonstrate using PLC on-line testing features.

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and re-pair transmit-ters	C-12 Test dif-ferent field sensing ele-ments, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Cali-brate trans-mitters	C-15 Tune controllers: pneumatic and electronic	C-16 Trouble-shoot and re-pair plant com-puting systems relating to pro-cess controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and re-pair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and con figure smart field devices, i.e., transmit-ters and valves	C-35 Operate control systems including single element, cas-cade, ratio, and feedforward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Deter-mine proper tools, equip-ment, and ma terials to per-form the job	D-3 Coordi-nate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment iso-lation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibra-tion proce-dures	D-8 Follow specifications and proce-dures	D-9 Perform algebraic op-erations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibra-tion data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise proce-dures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Applica-tion of ISA/IC standards	F-5 Under-stand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Under-stand personal computers	F-10 Attend on-going safety training courses	F-11 Partici-pate in plant related train-ing	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

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Duty C

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INT-C1-HO

Test and Calibrate Pressure, Level, Flow, and Temperature Switches

Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Test pressure switches;
b. Test level switches;
c. Test flow switches;
d. Test temperature switches;
e. Calibrate pressure switches;
f. Calibrate level switches;
g. Calibrate flow switches; and,
h. Calibrate temperature switches.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, published by McGraw-Hill, Latest Edition:

Chapter	Title
9	Pressure Measurements
12	Flow Measurements
13	Liquid Level Measurements
14	Temperature Measurements

Module Outline:

I. Testing Pressure Switches
II. Testing Level Switches
III. Testing Flow Switches

IV. Testing Temperature Switches
V. Calibrating Pressure Switches
VI. Calibrating Level Switches
VII. Calibrating Flow Switches
VIII. Calibrating Temperature Switches

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

1. Instructor will demonstrate how to:
   a. Test pressure switches;
   b. Test level switches;
   c. Test flow switches;
   d. Test temperature switches;
   e. Calibrate pressure switches;
   f. Calibrate level switches;
   g. Calibrate flow switches; and,
   h. Calibrate temperature switches.

2. Student will demonstrate how to:
   a. Test pressure switches;
   b. Test level switches;
   c. Test flow switches;
   d. Test temperature switches;
   e. Calibrate pressure switches;
   f. Calibrate level switches;
   g. Calibrate flow switches; and,
   h. Calibrate temperature switches.

3. Instructor will grade student's ability to:
   a. Test pressure switches;
   b. Test level switches;
   c. Test flow switches;
   d. Test temperature switches;
   e. Calibrate pressure switches;
   f. Calibrate level switches;
   g. Calibrate flow switches; and,
   h. Calibrate temperature switches.

INT-C2-HO
Troubleshoot and Repair Pressure, Level, Flow, and Temperature Switches
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Troubleshoot pressure switches;
b. Troubleshoot level switches;
c. Troubleshoot flow switches;
d. Troubleshoot temperature switches;
e. Repair pressure switches;
f. Repair level switches;
g. Repair flow switches; and,
h. Repair temperature switches.

Reading Assignments

Industrial Instrumentation Fundamentals, Fribance, published by McGraw-Hill, Latest Edition:

Chapter	Title
9	Pressure Measurements
12	Flow Measurements
13	Liquid Level Measurements
14	Temperature Measurements

Module Outline:

I. Troubleshooting Pressure Switches
II. Troubleshooting Level Switches

III. Troubleshooting Flow Switches
IV. Troubleshooting Temperature Switches
V. Repairing Pressure Switches
VI. Repairing Level Switches
VII. Repairing Flow Switches
VIII. Repairing Temperature Switches

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C2-LW
Troubleshoot and Repair Pressure, Level, Flow, and Temperature Switches
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Troubleshoot pressure switches;
   b. Troubleshoot level switches;
   c. Troubleshoot flow switches;
   d. Troubleshoot temperature switches;
   e. Repair pressure switches;
   f. Repair level switches;
   g. Repair flow switches; and,
   h. Repair temperature switches.

2. Student will demonstrate how to:
   a. Troubleshoot pressure switches;
   b. Troubleshoot level switches;
   c. Troubleshoot flow switches;
   d. Troubleshoot temperature switches;
   e. Repair pressure switches;
   f. Repair level switches;
   g. Repair flow switches; and,
   h. Repair temperature switches.

3. Instructor will grade student's ability to:
   a. Troubleshoot pressure switches;
   b. Troubleshoot level switches;
   c. Troubleshoot flow switches;
   d. Troubleshoot temperature switches;
   e. Repair pressure switches;
   f. Repair level switches;
   g. Repair flow switches; and,
   h. Repair temperature switches.

INT-C3-HO
Adjust Dampers and Positioners
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Adjust damper; and,
b. Adjust positioners.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, published by McGraw-Hill, Latest Edition:

Chapter	Title
10	Transducer-Positioner

Module Outline:

I. Damper
II. Damper Major Components
III. Positioner
IV. Positioner Major Components
V. Adjusting the Damper
VI. Adjusting the Positioner

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C3-LW

Adjust Dampers and Positioners

Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Adjust damper; and,
   b. Adjust positioner.

2. Student will demonstrate how to:
   a. Adjust damper; and,
   b. Adjust positioner.

3. Instructor will grade student's ability to:
   a. Adjust damper; and,
   b. Adjust positioner.

INT-C4-HO
Troubleshoot Control Drive (Damper)
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to troubleshoot damper.

Reading Assignments:

Refrigeration and Air Conditioning Systems, Althouse, Goodheart-Willcox, Latest Edition:

Chapter	Title
19	Dampers

Module Outline:

I. Define Damper
II. Define Modulation
III. Operation of Damper
IV. Damper Types
V. Damper Components
VI. PM for Damper Components
VII. Troubleshooting Damper Components

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C4-LW
Troubleshoot Control Drive (Damper)
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Identify major parts of a damper;
   b. Classify dampers (butterfly, multiple blade and split damper);
   c. Compare manual to automatic operation;
   d. Explain purpose of fire damper;
   e. Perform PM on dampers; and,
   f. Troubleshoot damper.

2. Student will demonstrate how to:
   a. Identify major parts of a damper;
   b. Classify dampers (butterfly, multiple blade and split damper);
   c. Compare manual to automatic operation;
   d. Explain purpose of fire damper;
   e. Perform PM on dampers; and,
   f. Troubleshoot damper.

3. Instructor will grade student's ability to:
   a. Identify major parts of a damper;
   b. Classify dampers (butterfly, multiple blade and split damper);
   c. Compare manual to automatic operation;
   d. Explain purpose of fire damper;
   e. Perform PM on dampers; and,
   f. Troubleshoot damper.

INT-C5-HO
Test and Calibrate Indicators and Gauges
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Test indicators;
b. Test gauges;
c. Calibrate indicators; and,
d. Calibrate gauges.

Reading Assignments:

Industrial Instrumentation Fundamentals, Frabrane, McGraw-Hill Publisher, Latest Edition:

Chapter	Title
17	Indicating and Registering Equipment

Module Outline:

I. Major Parts of Indicators
II. Testing Procedure for Indicator
III. Calibration Procedures for Indicator
IV. Major Parts of Gauges
V. Testing Procedure for Gauges
VI. Calibration Procedure for Gauges

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C5-LW
Test and Calibrate Indicators and Gauges
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Test indicators;
   b. Test gauges;
   c. Calibrate indicators; and,
   d. Calibrate gauges.

2. Student will demonstrate how to:
   a. Test indicators;
   b. Test gauges;
   c. Calibrate indicators; and,
   d. Calibrate gauges.

3. Instructor will grade student's ability to:
   a. Test indicators;
   b. Test gauges;
   c. Calibrate indicators; and,
   d. Calibrate gauges.

INT-C6-HO
Troubleshoot and Repair Indicators
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshooter indicators; and,
b. Repair indicators.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishing, Latest Edition

Chapter	Title
19	Industrial Measurements

Module Outline:

I. Define Indicators
II. List Major Types of Indicators
III. Troubleshoot Indicator
IV. Repair Indicator

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C6-LW
Troubleshoot and Repair Indicators
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. List major types of indicators;
   b. Compare analog indicators to digital indicators;
   c. Describe how pressure indicator works;
   d. Describe how current indicator works;
   e. Describe how voltage indicator works; and,
   f. Use data logger.

2. Student will demonstrate how to:
   a. List major types of indicators;
   b. Compare analog indicators to digital indicators;
   c. Describe how pressure indicator works;
   d. Describe how current indicator works;
   e. Describe how voltage indicator works; and,
   f. Use data logger.

3. Instructor will grade student's ability to:
   a. List major types of indicators;
   b. Compare analog indicators to digital indicators;
   c. Describe how pressure indicator works;
   d. Describe how current indicator works;
   e. Describe how voltage indicator works; and,
   f. Use data logger.

INT-C7-HO
Test and Calibrate Transmitters
Attachment 1: MASTER Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Test pressure transmitter;
b. Test level transmitter;
c. Test flow transmitter;
d. Test temperature transmitter; and,
e. Test smart transmitter.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishing, Latest Edition:

Chapter	Title
19	Industrial Measurements

Module Outline:

I. Level Transmitters
II. Flow Transmitters
III. Pressure Transmitter
IV. Temperature Transmitter
V. Test Procedure for Transmitter

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C7-LW
Test and Calibrate Transmitters
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will:
   a. Demonstrate how to use:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   b. Demonstrate how to test:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.

2. Student will:
   a. Demonstrate how to use:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   b. Demonstrate how to test:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.

3. Instructor will grade student's ability to:
   a. Use:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   b. Test:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;

(4) Flow transmitter; and,
(5) Smart transmitter.

INT-C8-HO
Test and Calibrate Recorders
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test recorders; and,
b. Calibrate recorders.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishers, Latest Edition:

Chapter	Title
17	Indicators and Recording Equipment

Module Outline:

I. Strip Chart Recorder
II. Circular Chart Recorder
III. Event Recorder
IV. Digital Recorder
V. Testing Recorder
VI. Calibrating Recorder

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C8-LW
Test and Calibrate Recorders
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Test recorders; and,
   b. Calibrate recorders.

2. Student will demonstrate how to;
   a. Test recorders; and,
   b. Calibrate recorders.

3. Instructor will grade student's ability to:
   a. Test recorders; and,
   b. Calibrate recorders.

INT-C9-HO
Troubleshoot and Repair Recorders
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot recorders; and,
b. Repair recorders.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishing, Latest Edition:

Chapter	Title
19	Industrial Measurements

Module Outline:

I. Define Recorders
II. Strip Chart
III. Circular Chart
IV. Parts of Recorders
V. Printer
VI. Types of Printers
VII. Event Recorder

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C9-LA
Troubleshoot and Repair Recorders
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Troubleshoot strip chart recorder;
   b. Troubleshoot circular chart recorder;
   c. Repair strip chart recorder; and,
   d. Repair circular chart recorder.

2. Student will demonstrate how to:
   a. Troubleshoot strip chart recorder;
   b. Troubleshoot circular chart recorder;
   c. Repair strip chart recorder; and,
   d. Repair circular chart recorder.

3. Instructor will grade student's ability to:
   a. Troubleshoot strip chart recorder;
   b. Troubleshoot circular chart recorder;
   c. Repair strip chart recorder; and,
   d. Repair circular chart recorder.

INT-C10-HO
Troubleshoot Linear Variable Differential Transformers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to troubleshoot LVDT.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishing, Latest Edition:

Chapter	Title
10	Pressure Measurements

Module Outline:

I. Define LVDT
II. Parts of LVDT
III. Function of LVDT parts
IV. Troubleshoot LVDT

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C10-LW
Troubleshoot Linear Variable Differential Transformers
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Explain LVDT operation;
   b. Properly use LVDT;
   c. Troubleshoot LVDT; and,
   d. Test LVDT for proper operation.

2. Student will:
   a. Explain LVDT operation;
   b. Properly use LVDT;
   c. Troubleshoot LVDT; and,
   d. Test LVDT for proper operation.

3. Instructor will grade student's ability to:
   a. Explain LVDT operation;
   b. Properly use LVDT;
   c. Troubleshoot LVDT; and,
   d. Test LVDT for proper operation.

INT-C11-HO
Troubleshoot and Repair Transmitters
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Troubleshoot pressure transmitter;
b. Troubleshoot level transmitter;
c. Troubleshoot flow transmitter;
d. Troubleshoot temperature transmitter;
e. Troubleshoot smart transmitter;
f. Repair pressure transmitter;
g. Repair level transmitter;
h. Repair flow temperature;
i. Repair temperature transmitter; and,
j. Repair smart transmitter.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishing, Latest Edition:

Chapter	Title
19	Industrial Measurements

Module Outline:

I. Level Transmitters
II. Flow Transmitters
III. Pressure Transmitter
IV. Temperature Transmitter

V. Troubleshoot Procedure for Transmitter
VI. Repair Procedure for Transmitter

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C11-LW
Troubleshoot and Repair Transmitters
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Use:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   b. Troubleshoot:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   c. Repair:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.

2. Student will demonstrate how to:
   a. Use:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   b. Troubleshoot:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   c. Repair:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.

3. Instructor will grade student's ability to:
   a. Use:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   b. Troubleshoot:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.
   c. Repair:
      (1) Level transmitter;
      (2) Pressure transmitter;
      (3) Temperature transmitter;
      (4) Flow transmitter; and,
      (5) Smart transmitter.

INT-C12-HO
Test Different Field Sensing Elements, Flow, Temperature, Pressure, and Level
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Test flow element;
b. Test level element;
c. Test pressure element; and,
d. Test temperature element.

Reading Assignments:

Instrumentation, by Kirk, ATS Publishers, Latest Edition:

Chapter	Title
8	Control Element

Module Outline:

I. Flow Element
II. Level Element
III. Pressure Element
IV. Temperature Element

INT-C12-LA
Test Different Field Sensing Elements, Flow, Temperature, Pressure, and Level
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C12-LW
Test Different Field Sensing Elements, Flow, Temperature, Pressure, and Level
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Test flow element
   b. Test level element
   c. Test pressure element
   d. Test temperature element

2. Student will demonstrate how to:
   a. Test flow element
   b. Test level element
   c. Test pressure element
   d. Test temperature element

3. Instructor will grade student's ability to:
   a. Test flow element
   b. Test level element
   c. Test pressure element
   d. Test temperature element

INT-C13-HO
Install/Replace Field Sensing Elements
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Install field sensing elements; and,
b. Replace field elements.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishing, Latest Edition:

Chapter	Title
19	Industrial Measurements

Module Outline:

I. Definition
II. Manipulated Variable
III. Electric Actuators
IV. Pneumatic Actuators
V. Control Valves
VI. Hydraulic Actuators

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C13-LW

Install/Replace Field Sensing Elements

Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Install field sensing elements; and,
   b. Replace field elements.

2. Student will demonstrate how to:
   a. Install field sensing elements; and,
   b. Replace field elements.

3. Instructor will grade student's ability to:
   a. Install field sensing elements; and,
   b. Replace field elements.

INT-C14-HO
Calibrate Transmitters
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Name common types of transmitters; and,
b. Calibrate transmitters.

Reading Assignments:

Primary Calibration Standards, ISA. Latest Edition:

Chapter	**Title**
Workbook	Standards
	Manometers
	Deadweight Testers

Module Outline:

I. Define Transmitter
II. Types of Transmitters
III. Standards
IV. Manometers
V. Hydraulic Deadweight Testers
VI. Pneumatic Deadweight Testers
VII. Ice Bath Tester
VIII. Pressure Tester
IX. Glossary (Workbook)

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C14-LW
Calibrate Transmitters
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Use calibration test equipment; and,
   b. Calibrate transmitters.

2. Student will demonstrate how to:
   a. Use calibration test equipment; and,
   b. Calibrate transmitters.

3. Instructor will grade student's ability to:
   a. Use calibration test equipment; and,
   b. Calibrate transmitters.

INT-C15-HO
Tune Controllers: Pneumatic and Electronic
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Tune pneumatic controller; and,
b. Tune electronic controller.

Reading Assignments:

Instrumentation, by Kirk, ATS Publications, Latest Edition:

Chapter	Title
8	Control

Module Outline:

I. Purpose of Controllers
II. Kinds of Controllers
III. Controller Modes
IV. Controller Terminology
V. P
VI. I
VII. D
VII. PID
IX. Tuning
X. Pneumatic vs. Electronics

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C15-LW
Tune Controllers: Pneumatic and Electronic
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Tune pneumatic controller; and,
   b. Tune electronic controller

2. Student's will demonstrate how to:
   a. Tune pneumatic controller; and,
   b. Tune electronic controller

3. Instructor will grade student's ability to:
   a. Tune pneumatic controller; and,
   b. Tune electronic controller

INT-C16-HO
Troubleshoot and Repair Plant Computing Systems Relating to Process Controls
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Troubleshoot plant computing systems relating to process controls; and,
b. Repair plant computing systems relating to process controls.

Reading Assignments:

Instrumentation, by Kirk, ATS Publishers, Latest Edition:

Chapter	Title
14	Electric Controls

Module Outline:

I. Define Computer
II. Hardware
III. Software
IV. Process Controls
V. Computers in Process Controls

INT-C16-LA
Troubleshoot and Repair Plant Computing Systems
Relating to Process Controls
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C16-LW
Troubleshoot and Repair Plant Computing Systems Relating to Process Controls
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Troubleshoot plant computing systems relating to process controls; and,
   b. Repair plant computing systems relating to process controls.

2. Student will be graded on their ability to:
   a. Troubleshoot plant computing systems relating to process controls; and,
   b. Repair plant computing systems relating to process controls.

INT-C17-HO
Troubleshoot and Replace Solenoid Valves
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot solenoid valves; and,
b. Replace solenoid valves.

Reading Assignments:

Refrigeration-Air Conditioning System, Althouse, Goodheart-Wilcox Publishing, Latest Edition:

Chapter	Title
4	Controls

Module Outline:

I. Define Solenoid Valve
II. Parts of Solenoid Valve
III. Troubleshoot Steps
IV. Replacement Steps

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C17-LW
Troubleshoot and Replace Solenoid Valves
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Use solenoid valve;
   b. List parts of solenoid valve;
   c. Troubleshoot steps for solenoid valve; and,
   d. Replacement steps for solenoid valve.

2. Student will:
   a. Use solenoid valve;
   b. List parts of solenoid valve;
   c. Troubleshoot steps for solenoid valve; and,
   d. Replacement steps for solenoid valve.

3. Instructor will grade student's ability to:
   a. Use solenoid valve;
   b. List parts of solenoid valve;
   c. Troubleshoot steps for solenoid valve; and,
   d. Replacement steps for solenoid valve.

INT-C18-HO
Perform Preventive Maintenance Procedures for Field Devices
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to perform preventive maintenance for field devices.

Reading Assignments:

Westinghouse Electric Maintenance Hints, Westinghouse Electric Corporation, Latest Edition

Chapter	Title
2	Maintenance of Installed Equipment

Module Outline:

I. Define Preventive Maintenance
II. Define Predictive Maintenance
III. Reliability and Maintenance
IV. Remote Marginal Equipment
V. Recondition Old Equipment
VI. Maintenance of New Equipment
VII. Equipment Familiarity
VIII. Scheduled Inspections
IX. Typical Maintenance Equipment
X. Equipment Start-Up
XI. Performance Data
XII. Determine Critical Equipment

XIII. Records
XIV. Housekeeping

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C18-LW

Perform Preventive Maintenance Procedures for Field Devices

Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate:
   a. Performing P.M. on a piece of equipment (This could be picked from the Westinghouse maintenance hints or an instrumentation vendors manuals.); and,
   b. Software P.M. program usage.

2. Student will demonstrate proficiency of selected P.M. procedures and using P.M. software.

INT-C19-HO
Test and Replace Thermocouples
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test thermocouples; and,
b. Replace thermocouples.

Reading Assignments:

Refrigeration and Air Conditioning, Althouse, Goodheart-Willcox Publishers, Latest Edition:

Chapter	Title
20	Heating Systems

Module Outline:

I. Define Thermocouple
II. How Thermocouple Works
III. Types of Thermocouples
IV. Test Thermocouple
V. Replace Thermocouple
VI. Powerpile
VII. RTD

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C19-LW
Test and Replace Thermocouples
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Identify common types of thermocouples;
   b. Test a thermocouple;
   c. Replace a thermocouple;
   d. Identify a powerpile;
   e. Identify a RTO;
   f. Test a RTD; and,
   g. Test a powerpile.

2. Student will demonstrate how to:
   a. Identify common types of thermocouples;
   b. Test a thermocouple;
   c. Replace a thermocouple;
   d. Identify a powerpile;
   e. Identify a RTO;
   f. Test a RTD; and,
   g. Test a powerpile.

3. Instructor will grade student's ability to:
   a. Identify common types of thermocouples;
   b. Test a thermocouple;
   c. Replace a thermocouple;
   d. Identify a powerpile;
   e. Identify a RTO;
   f. Test a RTD; and,
   g. Test a powerpile.

INT-C20-HO
Check and Test Vibration Sensing Elements
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Check vibration sensing elements; and,
b. Test vibration sensing elements.

Reading Assignments:

Mechanical Vibrations, Hartoq-Dover Publishers, Latest Edition:

Chapter	Title
6	Rotating Machinery

Module Outline:

I. Vibration
II. Frequency
III. Resonance
IV. Displacement
V. Velocity
VI. Acceleration
VII. Natural Frequency
VIII. Amplitude
IX. Spectrum Plot
X. Compression
XI. Extraction

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C20-LW
Check and Test Vibration Sensing Elements
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Check vibration sensing elements; and,
   b. Test vibration sensing elements.

2. Student will:
   a. Check vibration sensing elements; and,
   b. Test vibration sensing elements.

3. Instructor will grade student's ability to:
   a. Check vibration sensing elements; and,
   b. Test vibration sensing elements.

INT-C21-HO
Inspect and Troubleshoot Power Supplies and Converters
Attachment 1: MASTER Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop:
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot power supply; and,
b. Repair power supply.

Reading Assignments:

Instrumentation, by Kirk, ATS Publishers, Latest Edition:

Chapter	Title
8	Electricity

Module Outline:

I. Define Power Supply
II. Single Phase Power Supply
III. Transformer
IV. Regulator
V. Filter
VI. Conversion
VII. Three Phase Power Supply

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C21-LW
Inspect and Troubleshoot Power Supplies and Converters
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Troubleshoot power supply; and,
   b. Repair power supply.

2. Student will demonstrate how to:
   a. Troubleshoot power supply; and,
   b. Repair power supply.

3. Instructor will grade students ability to:
   a. Troubleshoot power supply; and,
   b. Repair power supply.

INT-C22-HO
Test and Calibrate Control Valve Actuators
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test control valve actuator; and,
b. Calibrate control valve actuator.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishers, Latest Edition

Chapter	Title
11	Liquid and Flow Measurements

Module Outline:

I. Define Control Valve
II. Parts of Control Valve
III. Globe Valve
  A. Single seat
  B. Double seat
IV. Three Way Valve
V. Eccentric Disk Valve
VI. Valve Characteristics
VII. Actuator Selection
VIII. Test Control Valve
IX. Calibrate Control Valve

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C22-LW
Test and Calibrate Control Valve Actuators
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. List parts of control valve;
   b. Globe valve-list parts;
      (1) Single seat;
      (2) Double seat;
   c. Three way valve-list parts;
   d. Eccentric disk valve-list parts;
   e. Valve characteristics-list;
   f. Select an actuator;
   g. Test control valves; and,
   h. Calibrate control valves.

2. Student will demonstrate how to:
   a. List parts of control valve;
   b. Globe valve-list parts;
      (1) Single seat;
      (2) Double seat;
   c. Three way valve-list parts;
   d. Eccentric disk valve-list parts;
   e. Valve characteristics-list;
   f. Select an actuator;
   g. Test control valves; and,
   h. Calibrate control valves.

3. Instructor will grade student's ability to:
   a. List parts of control valve;
   b. Globe valve-list parts;
      (1) Single seat;
      (2) Double seat;
   c. Three way valve-list parts;
   d. Eccentric disk valve-list parts;
   e. Valve characteristics-list;
   f. Select an actuator;
   g. Test control valves; and,
   h. Calibrate control valves.

INT-C23-HO
Troubleshoot and Repair Control Valves and Positioners
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot control valve/positioners; and,
b. Repair control valve/positioners.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publishers, Latest Edition:

Chapter	Title
11	Liquid and Flow Measurements

Module Outline:

I. Define Positioner
II. Parts of Positioner
III. Positioner Characteristics
IV. Positioner Selection
V. Troubleshoot Control Valve
VI. Repair Control Valve
VII. Troubleshoot Positioner
VIII. Repair Positioner

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C23-LW
Troubleshoot and Repair Control Valves and Positioners
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Identify the parts of a positioner;
   b. Select a positioner;
   c. Troubleshoot control valve;
   d. Repair a control valve;
   e. Troubleshoot a positioner; and,
   f. Repair a positioner.

2. Student will demonstrate how to:
   a. Identify the parts of a positioner;
   b. Select a positioner;
   c. Troubleshoot control valve;
   d. Repair a control valve;
   e. Troubleshoot a positioner; and,
   f. Repair a positioner.

3. Instructor will grade student's ability to:
   a. Identify the parts of a positioner;
   b. Select a positioner;
   c. Troubleshoot control valve;
   d. Repair a control valve;
   e. Troubleshoot a positioner; and,
   f. Repair a positioner.

INT-C24-HO
Test and Calibrate Controllers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test controllers; and,
b. Calibrate controllers.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
8	Controls

Module Outline:

I. Define Controller
II. On/Off Control
III. Proportional Control
IV. Integral Control
V. Derivative Control
VI. Testing Procedures
VII. Calibration Procedure

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C24-LW
Test and Calibrate Controllers
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Define controller;
   b. Identify on/off control;
   c. Identify proportional control;
   d. Identify integral control;
   e. Identify derivative control;
   f. Apply testing procedures; and,
   g. Apply calibration procedure.

2. Students will demonstrate how to:
   a. Define controller;
   b. Identify on/off control;
   c. Identify proportional control;
   d. Identify integral control;
   e. Identify derivative control;
   f. Apply testing procedures; and,
   g. Apply calibration procedure.

3. Instructor will grade student's ability to:
   a. Define controller;
   b. Identify on/off control;
   c. Identify proportional control;
   d. Identify integral control;
   e. Identify derivative control;
   f. Apply testing procedures; and,
   g. Apply calibration procedure.

INT-C25-HO
Troubleshoot and Repair Local Controllers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
- Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot controllers; and,
b. Repair controllers.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
8	Controls

Module Outline:

I. Troubleshooting Principles
II. Types of Controllers
III. Controller Parts
IV. Troubleshooting Controllers
V. Repair Controllers

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C25-LW
Troubleshoot and Repair Local Controllers
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Use troubleshooting principles;
   b. Identify types of controllers;
   c. Identify and list controller parts;
   d. Troubleshoot controllers; and,
   e. Repair controllers.

2. Student will demonstrate how to:
   a. Use troubleshooting principles;
   b. Identify types of controllers;
   c. Identify and list controller parts;
   d. Troubleshoot controllers; and,
   e. Repair controllers.

3. Instructor will grade student's ability to:
   a. Use troubleshooting principles;
   b. Identify types of controllers;
   c. Identify and list controller parts;
   d. Troubleshoot controllers; and,
   e. Repair controllers.

INT-C26-HO
Troubleshoot and Repair Electronic Computing Relays
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot electronic computing relays; and,
b. Repair electronic computing relays.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
8	Control

Module Outline:

I. Define Electronic Computing Relay
II. List Parts of Electronic Computing Relay
III. List Operation of Electronic Computing Relay
IV. Troubleshoot Electronic Computing Relay
V. Repair Electronic Computing Relay

INT-C26-LA
Troubleshoot and Repair Electronic Computing Relays
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Troubleshoot electronic computing relay; and,
   c. Repair electronic computing relay.

INT-C26-LW
Troubleshoot and Repair Electronic Computing Relays
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Troubleshoot electronic computing relay; and,
   b. Repair electronic computing relay.

2. Student will demonstrate how to:
   a. Troubleshoot electronic computing relay; and,
   b. Repair electronic computing relay.

3. Instructor will grade student's ability to:
   a. Troubleshoot electronic computing relay; and,
   b. Repair electronic computing relay.

INT-C27-HO
Test and Calibrate Gas Analyzers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test gas analyzers; and,
b. Calibrate gas analyzers.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
13	Analysis

Module Outline:

I. Define Gas Analyzer
II. Conductivity
III. Absorption
IV. Concentration
V. Density
VI. Combustibility
VII. Parts for a Gas Analyzer
VIII. Gas Analyzer
IX. Repair Gas Analyzer

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C27-LW
Test and Calibrate Gas Analyzers
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Test gas analyzers; and,
   b. Calibrate gas analyzers.

2. Student's will demonstrate how to:
   a. Test gas analyzers; and,
   b. Calibrate gas analyzers.

3. Instructor will grade student's ability to:
   a. Test gas analyzers; and,
   b. Calibrate gas analyzers.

INT-C28-HO
Test and Calibrate Air Analyzers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test air analyzer; and,
b. Calibrate air analyzer.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	**Title**
13	Analysis

Module Outline:

I. Define Air Analyzer
II. Major Parts of Air Analyzer
III. Probes Used with Air Analyzer
IV. Testing Air Analyzer
V. Calibrating Air Analyzers

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C28-LW
Test and Calibrate Air Analyzers
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Test air analyzer; and,
   b. Calibrate air analyzer.

2. Student will demonstrate how to:
   a. Test air analyzer; and,
   b. Calibrate air analyzer.

3. Instruction will grade student's ability to:
   a. Test air analyzer; and,
   b. Calibrate air analyzer.

INT-C29-HO
Test and Calibrate Water Analyzers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Test water analyzers; and,
b. Calibrate water analyzers.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
13	Analysis

Module Outline:

I. Define Water Analyzer
II. List Major Components of Water Analyzer
III. Properties to Be Measured
IV. Testing Procedure
V. Calibration Procedure

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C29-LW
Test and Calibrate Water Analyzers
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Test water analyzers; and,
   b. Calibrate water analyzers.

2. Student will demonstrate how to:
   a. Test water analyzers; and,
   b. Calibrate water analyzers.

3. Instructor will grade student's ability to:
   a. Test water analyzers; and,
   b. Calibrate water analyzers.

INT-C30-HO
Troubleshoot Servo Valves
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to troubleshoot servo valves.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
14	Control Valves

Module Outline:

I. Define Servo
II. Define Valve
III. Define Servo Valve
IV. Operation of Servo Valve
V. Maintenance of Servo Valve
VI. Troubleshoot Servo Valve

INT-C30-LA
Troubleshoot Servo Valves
Attachment 2: **MASTER** Laboratory Aid

1, Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Troubleshoot servo valve.

INT-C30-LW
Troubleshoot Servo Valves
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to troubleshoot servo valves.

2. Student will demonstrate how to troubleshoot servo valves.

3. Instructor will grade student's ability to troubleshoot servo valves.

INT-C31-HO
Calibrate Servo Valves
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Calibrate servo valves;
b. Define servo valve; and,
c. Identify servo valve.

Reading Assignments:

Instrumentation, Kirk; ATS Publishers, Latest Edition

Chapter	**Title**
14	Control Valves

Module Outline:

I. Define Valve
II. Define Servo
III. Define Servo Valve
IV. Parts of Servo Valve
V. How Servo Valve Works
VI. Servo Valve Calibration
VII. Servo Valve Maintenance

INT-C31-LA
Calibrate Servo Valves
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Calibrate a servo valve.

INT-C31-LW
Calibrate Servo Valves
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Calibrate servo valves;
   b. Define servo valve; and,
   c. Identify servo valve.

2. Student will demonstrate how to:
   a. Calibrate servo valves;
   b. Define servo valve; and,
   c. Identify servo valve.

3. Instructor will grade student's ability to:
   a. Calibrate servo valves;
   b. Define servo valve; and,
   c. Identify servo valve.

INT-C32-HO
Test and Clean Video Display Unit
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Clean video display unit; and,
b. Test video display unit.

Module Outline:

I. Clean Video Display Unit
II. Test Video Display Unit

INT-C32-LA
Test and Clean Video Display Unit
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   a. Insure proper tools and materials are available for project completion;
   b. Insure proper techniques and safety procedures are followed in completing the project; and,
   c. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   a. Clean video display unit; and,
   b. Test video display unit.

INT-C32-LW
Test and Clean Video Display Unit
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Clean video display unit; and,
   b. Test video display unit.

2. Student will demonstrate how to:
   a. Clean video display unit; and,
   b. Test video display unit.

3. Instructor will grade student's ability to:
   a. Clean video display unit; and,
   b. Test video display unit.

INT-C33-HO
Check and Adjust Video Display Unit
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Check video display unit; and,
b. Adjust video display unit.

Module Outline:

I. Check Video Display Unit
II. Adjust Video Display Unit

Check and Adjust Video Display Unit
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Check video display unit; and,
   c. Adjust video display unit.

INT-C33-LW
Check and Adjust Video Display Unit
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Check video display unit; and,
   b. Adjust video display unit.

2. Student will demonstrate how to:
   a. Check video display unit; and,
   b. Adjust video display unit.

3. Instructor will grade student's ability to:
   a. Check video display unit; and,
   b. Adjust video display unit.

INT-C34-HO
Design, Specify and Configure Smart Field Devices, i.e., Transmitters and Valves
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Configure smart transmitters;
b. Configure valve operation;
c. Specify smart transmitters; and,
d. Design smart transmitters parameters.

Reading Assignments:

Rosemount Vendor Manual-Rosemount 260 Smart Transmitter (Entire Pamphlet), Latest Edition

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Module Outline:

I. Configure Smart Transmitters
II. Configure Valve Operation
III. Specify Smart Transmitters
IV. Design Smart Transmitters Parameters

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C34-LW
Design, Specify and Configure Smart Field Devices, i.e., Transmitters and Valves
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:

Practical Exercise **CALIBRATING A SMART TRANSMITTER**		
List answers and steps.	YES	NO
Initiate communications with the transmitter		
What is the current tag name of the transmitter?		
Change the tag name to 5TT204-2.		
What is the temperature range of the transmitter?		
Change the temperature range to 0-300 degree C.		
What is the damping time of the transmitter?		
Change the damping time to 2.00 sec.		
What is the current temperature reading and the resultant ma output? Record values: PV _____ deg C. Output = _____ ma		
Change the tag name back to First Try.		
Change the range back to 0-400 degrees C.		
Change the damping back to 2.00 sec.		

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2. Student will practice:

Practical Exercise CALIBRATING A SMART TRANSMITTER		
List answers and steps.	YES	NO
Initiate communications with the transmitter		
What is the current tag name of the transmitter?		
Change the tag name to 5TT204-2.		
What is the temperature range of the transmitter?		
Change the temperature range to 0-300 degree C.		
What is the damping time of the transmitter?		
Change the damping time to 2.00 sec.		
What is the current temperature reading and the resultant ma output? Record values: PV _____ deg C. Output = _____ ma		
Change the tag name back to First Try.		
Change the range back to 0-100 degrees C.		
Change the damping back to 2.00 sec.		

INT-C35-HO
Operate Control Systems Including Single Element, Cascade, Ratio, and Feedforward
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Operate single element control system;
b. Operate cascade element control system;.
c. Operate ratio element control system; and,
d. Operate feedforward element control systems.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
8	Controls

Module Outline:

I. Single Element Control System
II. Cascade Element Control System
III. Ratio Element Control System
IV. Feedforward Element Control Systems

INT-C35-LA
Operate Control Systems Including Single Element, Cascade, Ratio, and Feedforward
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   a. Operate single element control system;
   b. Operate cascade element control system;
   c. Operate ratio element control system; and,
   d. Operate feedforward element control systems.

INT-C35-LW
Operate Control Systems Including Single Element, Cascade, Ratio, and Feedforward
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Operate single element control system;
   b. Operate cascade element control system;
   c. Operate ratio element control system; and,
   d. Operate feedforward element control systems.

2. Student will demonstrate how to:
   a. Operate single element control system;
   b. Operate cascade element control system;
   c. Operate ratio element control system; and,
   d. Operate feedforward element control systems.

3. Instructor will grade student's ability to:
   a. Operate single element control system;
   b. Operate cascade element control system;
   c. Operate ratio element control system; and,
   d. Operate feedforward element control systems.

INT-C36-HO
Troubleshoot and Repair Analyzers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Troubleshoot analyzers; and,
b. Repair analyzers.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	**Title**
13	Analysis

Module Outline:

I. Troubleshooting Procedure
II. Repair Procedures

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-C36-LW
Troubleshoot and Repair Analyzers
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Troubleshoot analyzers; and,
   b. Repair analyzers.

2. Student will demonstrate how to:
   a. Troubleshoot analyzers; and,
   b. Repair analyzers.

3. Instructor will grade student's ability to:
   a. Troubleshoot analyzers; and,
   b. Repair analyzers.

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and re-pair transmit-ters	C-12 Test dif-ferent field sensing ele-ments, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Cali-brate trans-mitters	C-15 Tune controllers: pneumatic and electronic	C-16 Trouble-shoot and re-pair plant com-puting systems relating to pro-cess controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and re-pair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and con figure smart field devices, i.e., transmit-ters and valves	C-35 Operate control systems including single element, cas-cade, ratio, and feedforward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Deter-mine proper tools, equip-ment, and ma-terials to per-form the job	D-3 Coordi-nate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment iso-lation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibra-tion proce-dures	D-8 Follow specifications and proce-dures	D-9 Perform algebraic op-erations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibra-tion data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise proce-dures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Applica-tion of ISA/IC standards	F-5 Under-stand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Under-stand personal computers	F-10 Attend on-going safety training courses	F-11 Partici-pate in plant related train-ing	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

INT-D1-HO
Organize Documents and Drawings Required on the Job
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Organize and secure P&ID drawing;
b. Organize and secure calibration vendor information;
c. Organize and secure calibration blank forms; and,
d. Organize and secure previous calibration sheets.

Module Outline:

I. P&ID Drawings
II. Calibration Sheets Format
III. Completed Calibration Sheets Format
IV. Calibration Vendor Information

INT-D1-LA
Organize Documents and Drawings Required on the Job
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-D1-LW

Organize Documents and Drawings Required on the Job

Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Organize and secure P&ID drawing;
   b. Organize and secure calibration vendor information;
   c. Organize and secure calibration blank forms; and,
   d. Organize and secure previous calibration sheets.

2. Student will practice:
   a. Organize and secure P&ID drawing;
   b. Organize and secure calibration vendor information;
   c. Organize and secure calibration blank forms; and,
   d. Organize and secure previous calibration sheets.

INT-D2-HO
Determine Proper Tools, Equipment, and Materials to Perform the Job
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Determine proper tools to perform the job;
b. Determine proper equipment to perform the job; and,.
c. Determine proper materials to perform the job.

Module Outline:

I. Electrical Hand Tools
II. P&ID Drawings
III. VOM
IV. Process Variables
V. Instruments for Measuring Process Variable

INT-D2-LA
Determine Proper Tools, Equipment, and Materials to Perform the Job
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-D2-LW
Determine Proper Tools, Equipment, and Materials to Perform the Job
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Determine proper tools to perform the job;
   b. Determine proper equipment to perform the job; and,
   c. Determine proper materials to perform the job.

2. Student will practice:
   a. Determine proper tools to perform the job;
   b. Determine proper equipment to perform the job; and,
   c. Determine proper materials to perform the job.

3. Instructor will grade student's performance on:
   a. Determine proper tools to perform the job;
   b. Determine proper equipment to perform the job; and,
   c. Determine proper materials to perform the job.

INT-D3-HO
Coordinate Work Activities with Other Crafts or Units
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Coordinate work activities with console operators;
b. Coordinate work activities with field operators; and,
c. Coordinate work activities with maintenance workers.

Module Outline:

I. Console Operator Duties
II. Field Operator Duties
III. Maintenance Worker Duties

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-D3-LW
Coordinate Work Activities with Other Crafts or Units
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Coordinate work activities with console operators;
   b. Coordinate work activities with field operators; and,
   c. Coordinate work activities with maintenance workers.

2. Student will demonstrate how to:
   a. Coordinate work activities with console operators;
   b. Coordinate work activities with field operators; and,
   c. Coordinate work activities with maintenance workers.

3. Instructor will grade student's ability to:
   a. Coordinate work activities with console operators;
   b. Coordinate work activities with field operators; and,
   c. Coordinate work activities with maintenance workers.

INT-D4-HO
Coordinate Preventive Maintenance Schedule with Planning Group
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Define preventive maintenance;
b. Define planning group;
c. List communication techniques; and,
d. List common communication procedures.

Module Outline:

I. Define Preventive Maintenance
II. Define Planning Group
III. List Communication Techniques
IV. List Common Communication Procedures

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-D4-LW
Coordinate Preventive Maintenance Schedule with Planning Group
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will:
   a. Identify safety equipment appropriate to protect the eyes from flying particle matter or chemicals;
   b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
   c. Identify equipment appropriate to protect against high level of noise;
   d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,
   e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

2. Student will:
   a. Identify safety equipment appropriate to protect the eyes from flying particle matter or chemicals;
   b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
   c. Identify equipment appropriate to protect against high level of noise;
   d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,
   e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

3. Instructor will grade student's performance in:
   a. Identify safety equipment appropriate to protect the eyes from flying particle matter or chemicals;
   b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
   c. Identify equipment appropriate to protect against high level of noise;
   d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials; and,
   e. Identify safety equipment appropriate to protect the lungs from chemicals or particles.

INT-D5-HO
Verify Equipment Isolation
Prior to Performance of Work for Safety Reasons
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Read P&ID diagrams;
b. List specific steps in order to isolate equipment; and,
c. Demonstrate knowledge of safety rules and regulations in handling corrosive materials.

Module Outline:

I. Instrumentation Symbols
II. P&ID Diagrams
III. Isolation Procedures
IV. Procedures to Go from Isolation Back to Normal Operation
V. Documentation to Support Isolation Procedures

INT-D5-LA
Verify Equipment Isolation
Prior to Performance of Work for Safety Reasons
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-D5-LW
Verify Equipment Isolation
Prior to Performance of Work for Safety Reasons
Attachment 3: ***MASTER*** *Laboratory Worksheet*

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1. Instructor will demonstrate:
   a. Isolation procedure; and,
   b. Change back from isolation to normal operation.

2. Student will practice:
   a. Isolation procedure; and,
   b. Change back from isolation to normal operation.

3. Instructor will grade student on performance of:
   a. Isolation procedure; and,
   b. Change back from isolation to normal operation.

INT-D6-HO

Report Abnormal Equipment Problems to Supervisor

Attachment 1; MASTER Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Report abnormal equipment problems to supervisor (team leader); and,
b. Recognize abnormal equipment problems.

Module Outline:

I. Recognize Abnormal Equipment Problems
II. Five Senses
    A. Hear-unusual sounds
    B. See-discolor, burn
    C. Touch-unusual hot or cold
    D. Feel-unusual shape or size
    E. Smell-burn, unusual small
III. Use Five Senses to Recognize Abnormal Equipment Problem
IV. Report Abnormal Equipment Problems to Supervisor

INT-D7-HO
Write New Calibration Procedures If Needed
Attachment 1: MASTER Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to write new calibration procedures.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Publication, Latest Edition:

Chapter	Title
10	Measurement

Module Outline:

I. Define Calibration Procedures
II. Sections of Calibration Procedures
III. Using Calibration Procedure
IV. Getting Acquainted with Calibration Device
V. Equipment Necessary to Perform Calibration
VI. Calibration Steps
VII. Interpretation of Calibration Results
VIII. Forms to Record Calibration Values
IX. NIST Calibration Standards
X. Standards
XI. Interview SME (IE Tech)

INT-D7-LA
Write New Calibration Procedures If Needed
Attachment 2: **MASTER** Laboratory Aid

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1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Write a sample calibration procedure.

INT-D7-LW
Write New Calibration Procedures If Needed
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to write sample calibration procedure.

2. Student will write a calibration procedure.

3. Student will be graded on ability to write sample calibration procedure.

INT-D8-HO
Follow Specification and Procedures
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to follow specifications and procedures.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
1	Characteristics of Instruments

Module Outline:

I. Define Specifications
II. Major Areas of Specification
III. Who Writes Specifications
IV. How to Apply Specification
V. SPC
VI. Quality
VII. Control Charts

INT-D9-HO
Perform Basic Algebraic Operations
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate ability to use formulas to solve mathematical problems.

Objectives:

Upon completion of this module the student will be able to:

a. Define formula;
b. Define equation;
c. Define term;
d. Demonstrate that you understand what combinations of letters and numbers or letters indicate in formulas;
e. Demonstrate that you understand what parentheses or brackets indicate in formulas;
f. Change certain sentences about mathematical relationships into formulas; and,
g. Demonstrate that you can rearrange formulas in order to find various unknowns.

Rules for Dealing with Formulas:

1. A formula is a way of briefly expressing a rule, fact, or principle by the use of symbols or letters.

2. Formulas are equations. An equation is a statement that the quantities on each side of the equal sign equal the same thing.

3. Combinations of letters and/or numbers indicate multiplication.

4. Parentheses ( ) or brackets [ ] are grouping symbols. They indicate that the quantities within them are to be grouped together, and are to be considered as one quantity. When working with formulas that have parentheses, first do the operation indicated within the parentheses. When both brackets and parentheses are present work within the brackets.

5. Formulas state relationships that have been tested and proven to be true. A formula is a sentence where letters, symbols, and numbers substitute for words.

6. Sometimes, you know the value of the quantity to the left of the equal sign, but not all the values to the right. You can still work the formula by reattaching it.

7. There are some rules of procedure you must follow when you rearrange equations. One important principle is cancellation. Cancellation removes a common element from a fractions numerator and denominator on one side of an equation.

8. Another important principle states that what is done to one side an equation, must be done to the other side. Another principle used in solving formula is transposition. This states that when you move quantity form one side of an equation to the other, you change its sign or operation.

Reading Assignments:

*The following chapters are assigned to read from **Math for Consumers**, D.S. Kaine and L.S. Kaine, Advisor-Wesley Pub. Co., Latest Edition:*

Chapter	*Title*
	Equation Solving

Module Outline:

I. Formula Components
   Terms, brackets, parentheses, letters, number
II. What a Formula Does
   State Relationships
III. Principles for Solving Formulas
IV. Ratio for Solving Formulas
V. Practice Using Formulas

Glossary:

Cancellation
Removing a common element from a numerator and a denominator of a fraction on one side of an equation.

Equation
A statement that two quantities are equal.

Formula
A way of briefly expressing a rule, fact, or principle by the use of symbols or letters. A formula is an equation.

Term

Numbers or symbols combined by multiplication, division, addition, or subtraction.

Transportation

The process of moving a quantity from one side of an equation to the other by changing its sign of operation.

INT-D9-LW
Perform Basic Algebraic Operations
Attachment 2: **MASTER** Laboratory Worksheet

Worksheet:

1. Formulas:
   a. are equations.
   b. show how some quantities are related to each other.
   c. state relationships which have been tested and proven to be true.
   d. all of the above.

2. In a formula terms are:
   a. numbers or symbols combined by addition or subtraction.
   b. numbers or symbols combined by addition, subtraction, multiplication, or division.
   c. numbers or symbols.
   d. none of the above.

3. Parentheses or brackets in a formula mean:
   a. quantities within them are to be grouped together.
   b. quantities within them are to be considered one quantity.
   c. first do the work indicated within the parentheses.
   d. all of the above.

4. Write the formula for the following sentence. Profit (P) equals the margin (M) minus the overhead (O).

   _____

5. Write the formula for the following sentence. The amperage (A) of an electrical circuit is equal to the wattage (W) divided by the voltage (V).

   _____

6. Write the sentence for the following formula. I=PRT (I is interest on money, P is principal, R is rate, and T is time).

   _____

7. Write the sentence for the following formula. HP=VA/746 horsepower on an electric motor, V is volts, and a amperes.

   _____

INT-D10-HO
Perform Basic Trigonometric Functions
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the classroom by not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Solve trigonometric functions use a sin equation.;
b. Solve trigonometric functions use a cos equation;
c. Solve trigonometric functions use a csc equation;
d. Solve trigonometric functions use a tan equation;
e. Solve trigonometric functions use a cot equation;
f. Solve trigonometric functions use a sec equation;
g. Solve for unknown sides, angles or radians for a right triangle;
h. Convert radians to degrees; and,
i. Convert degrees to radians.

Reading Assignments:

The following chapters are assigned to read from *Mathematics for Technicians* by Edward Tronaas, Prentice Hall Publishers, Latest Edition:

Chapter	Title
9	Trigonometry

Module Outline:

I. Solve Trigonometric Functions Use a Sin Equation
II. Solve Trigonometric Functions Use a Cos Equation
III. Solve Trigonometric Functions Use a Csc Equation
IV. Solve Trigonometric Functions Use a Tan Equation
V. Solve Trigonometric Functions Use a Cot Equation
VI. Solve Trigonometric Functions Use a Sec Equation
VII. Solve For Unknown Sides, Angles or Radians For a Right Triangle
VIII. Convert Radians to Degrees
IX. Convert Degrees to Radians

INT-D10-LW
Perform Basic Trigonometric Functions
Attachment 2: **MASTER** Laboratory Worksheet

Worksheet:

(Use Trig Function Tables)

Solve:

1. Sin 22° 18' = _____
2. Cot 22° 18' = _____
3. Sec 22° 18' = _____
4. Tan 22° 18' = _____
5. Csc 22° 18' = _____
6. Cos 22° 18' = _____
7. Cos A = 0.69675 _____
8. Cot A = 1.1340 _____
9. Sin A = 0.98531 _____
10. Sec A = 1.5753 _____
11. Tan A = 0.50587 _____
12. 2π Radians = _____ Degrees
13. 180 Degrees = _____ Radians
14. π Radians = _____ Degrees

INT-D11-HO
Perform Basic Calculus Operations
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to solve for:

a. Limits;
b. Derivatives;
c. Graphs;
d. Unknowns using differentiation;
e. Differentials using trigonometric functions;
f. Differentials using logarithms;
g. Higher order derivatives;
h. Differentials using exponentials;
i. Area under a curve;
j. Unknowns using integration;
k. Definite integrals; and,
l. Numerical integration.

Reading Assignments:

Quick Calculus, Kleppner and Ramsey, John Wiley Company Publishing, Latest Edition:

Chapter	Title
2	Differential Calculus
3	Integral Calculus

Module Outline:

I. Limits
II. Derivatives
III. Graphs of Functions
IV. Differentiation
V. Differentiating Trigonometric Functions
VI. Differentiation of Logarithms and Exponentials
VII. Higher Order Derivatives
VIII. Differentials
IX. Area under a Curve
X. Integration
XI. Techniques of Integration
XII. Definite Integrals and Numerical Integration

INT-D11-LW
Perform Basic Calculus Operations
Attachment 2: **MASTER** Laboratory Worksheet

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1. A set is a **collection of objects.**

2. A function is a **rule that assigns to each element in a set.**

3. Angles are measured in either **degrees or radians.**

4. 1 rad = **360°** divided by **2 π.**

5. What is the definition of a limit? **Let *f(x)* be defined for all x in an interval about *x=a*, but not necessarily at *x=a*. If there is an number L such tat to each positive number ∈ there corresponds a positive number δ such that;**
   $|f(x) - L| < \epsilon$ provided $0 < |x - a| < \delta$.
   Therefore, L is the limit of *f(x)* as *x* approaches *a*.

6. If *y=f(x)*, then the rate of change of y with respect to x is;

   ***lim* ($\Delta y/\Delta x$). The lim ($\Delta y/\Delta x$) is called the derivative of *y* with respect to *x*, [($\Delta x \to 0$), ($\Delta y \to 0$)] and may be written written as (dy/dx).**

7. Plot $y = mx + b$.

8. Let u and v be variables that depend on x.

   $[d(uv)/dx] = u\,[dv/dx] + v\,[du/dx] + 0$

9. $\sin(\theta + \varnothing) = \sin\theta \cos\varnothing + \cos\theta \sin\varnothing$

10. a to the m power times a to the n power equals **a to the m + n power.**

11. Log x is; **$x = 10$ to the log x power.**

12. If $A(x)$ is the area under the curve defined by $y = f(x)$, then;

    $[dA(x)/dx] = A'(x) = f(x)$.

13. Using integration solve for $F(x)$; **$F(x); = \int f(x)\,dx$.**

13. Using integration solve for $F(x)$; $F(x) = \int f(x)\,dx$.

14. Suppose the $A(x)$ under a curve is defined by the $y = f(x)$ is written as $A(x) = F(x) + C$, where $F(x)$ is any antiderivative of $f(x)$ and C is a constant. The area under the curve between $x = a$ and $x = b$ is then;
$A(b) = F(b) - F(a)$

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and re-pair transmit-ters	C-12 Test dif-ferent field sensing ele-ments, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Cali-brate trans-mitters	C-15 Tune controllers pneumatic and electronic	C-16 Trouble-shoot and re-pair plant com-puting systems relating to pro-cess controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and re-pair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate ox analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and con-figure smart field devices, i.e., transmit-ters and valves	C-35 Operate control systems including single element, cas-cade, ratio, and feedforward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Deter-mine proper tools, equip-ment, and ma-terials to per-form the job	D-3 Coordi-nate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment iso-lation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibra-tion proce-dures	D-8 Follow specifications and proce-dures	D-9 Perform algebraic op-erations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibra-tion data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise proce-dures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Applica-tion of ISA/IIC standards	F-5 Under-stand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Under-stand personal computers	F-10 Attend on-going safety training courses	F-11 Partici-pate in plant related train-ing	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

INT EMA
REV 1/98

Duty E

INT-E1-HO
Record Test/Calibration Data
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Record test data; and,
b. Record calibration data.

Module Outline:

I. Define Test
II. Define Calibration
III. Components of Test Sheet
IV. Components of Calibration Sheet

INT-E1-LA
Record Test/Calibration Data
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Demonstrate how to record test data in an organized, logical manner; and,
   c. Demonstrate how to record calibration data in an organized, logical manner.

INT-E1-LW
Record Test/Calibration Data
Attachment 3: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Construct test data sheet;
   b. Fill out test data sheet;
   c. Construct calibration sheet; and,
   d. Fill out calibration sheet.

2. Student will demonstrate how to:
   a. Construct test data sheet;
   b. Fill out test data sheet;
   c. Construct calibration sheet; and,
   d. Fill out calibration sheet.

3. Instructor will grade student's ability to:
   a. Construct test data sheet;
   b. Fill out test data sheet;
   c. Construct calibration sheet; and,
   d. Fill out calibration sheet.

INT-E2-HO
Record Preventive Maintenance Data
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Define preventive maintenance;
b. List common P.M. schedules; and,
c. List common P.M. data.

Reading Assignments:

Industrial Instrumentation Fundamentals, Fribance, McGraw-Hill Company, Latest Edition:

Chapter	**Title**
	Data Logging

Module Outline:

I. Preventive Maintenance Definition
II. Preventive Maintenance Data

INT-E2-LA
Record Preventive Maintenance Data
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-E3-HO
Record Equipment Disconnect Data
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to record equipment disconnect data for:

a. Fuses;
b. Circuit breakers;
c. Disconnects, and,
d. Protective relays.

Reading Assignments:

Electrical Systems, Kirk, Delmar Publishers, Latest Edition

Chapter	Title
6	Protective Services

Module Outline:

I. Define Disconnect
II. Fuses (define)
III. Fuse Classifications
  A. Dual element
  B. Single element
  C. Current limiting
  D. Voltage rating
  E. Current rating
  F. Interrupting rating
  G. Physical size

H. Type

IV. Define Circuit Breaker

V. Circuit Breaker Classification
   A. O
   B. OA
   C. FA
   D. FOA
   E. OCB
   F. Gas
   G. Metal clad
   H. Ratchet

VI. Define Disconnect

VII. Disconnect Classification
   A. 1ø
   B. 3ø

VIII. Protective Relay (define)

IX. Types of Protective Relays
   A. Over current
   B. Impedance
   C. Pilot wire
   D. Zone

INT-E3-LA
Record Equipment Disconnect Data
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Demonstrate how to record equipment disconnect data.

INT-E3-LW
Record Equipment Disconnect Data
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to record equipment disconnect data for:
   a. Fuses;
   b. Circuit breaker;
   c. Disconnects; and,
   d. Protective relays.

2. Student will demonstrate how to record equipment disconnect data and be graded on these areas:
   a. Fuses;
   b. Circuit breaker;
   c. Disconnects; and,
   d. Protective relays.

INT-E4-HO
Evaluate Collected Data
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Collect data; and,
b. Evaluate data.

Reading Assignments:

Instrumentation, Fribance, McGraw-Hill Publishers, Latest Edition:

The entire book

Module Outline:

I. Define Data
II. Classify Calibration Procedure
III. Define Job Performance Measure (JPM)
IV. Classify Installation Guide
V. Classify Maintenance Guide

INT-E4-LA
Evaluate Collected Data
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Demonstrate how to evaluate collected data.

INT-E4-LW
Evaluate Collected Data
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Collect data; and,
   b. Evaluate data.

2. Student will demonstrate how to:
   a. Collect data; and,
   b. Evaluate data.

3. Instructor will grade student's ability to:
   a. Collect data; and,
   b. Evaluate data.

INT-E5-HO
Review/Revise Procedures if Needed
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Review procedures;
b. Revise procedures; and,
c. Develop procedures.

Reading Assignments:

None - Company specific

Module Outline:

I. Define Procedures
II. Major Parts of Procedures
III. Compare Procedures to Lesson Plan

INT-E5-LA
Review/Revise Procedures if Needed
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project; and,
   b. Student will demonstrate how to write a procedure.

INT-E5-LW
Review/Revise Procedures if Needed
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Review procedures;
   b. Revise procedures; and,
   c. Develop procedures.

2. Student will demonstrate how to:
   a. Review procedures;
   b. Revise procedures; and,
   c. Develop procedures.

3. Instructor will grade student's ability to:
   a. Review procedures;
   b. Revise procedures; and,
   c. Develop procedures.

INT-E6-HO
Write Reports Required by Company
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to write reports required by company.

Module Outline:

I. Define Technical Reports
II. Cover Sheet
III. Table of Contents
IV. Purpose
V. Scope
VI. Calculation
VII. Charts
VIII. Results
IX. References

INT-E6-LW
Write Reports Required by Company
Attachment 2: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to write a technical report required by the company.

2. Student will demonstrate how to write a technical report required by the company.

3. Instructor will grade student's ability to write a technical report required by the company.

INT-E7-HO
Specify Equipment for Control Systems
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to specify and use:

a. Control relay;
b. Magnetic starter;
c. Reduced voltage starter;
d. Inputs; and,
e. Outputs.

Reading Assignments:

Industrial Motor Control, Alerich, Delmar Publishers, Latest Edition:

Chapter	Title
2	Motor Starters
3	Control Circuits
4	Basic Control Circuits
5	DC Motor Controls
6	AC Motor Controls
7	Motor Drives

Module Outline:

I. Introduction, Overview, General Principles of Motor Control, DC, Single Phase, Three Phase
II. Fractional HP Manual Motor Starters, Magnetic Motor Starters, Motors-DC, Single Phase And Three Phase

III. Push-Button Control, Relays, Contactors, and Magnetic Starters, Ladder Diagram
IV. Timing Relays, Counters
V Pressure Switches, Float Switches, Limit Switches, Two Wire Control, Three Wire Control Multiple Push-Button Stations
VI. Jog Control, Hand-Off Automatic Control, Drum Switch
VII. Sequence Control

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-E7-LW
Specify Equipment for Control Systems
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to properly use:
   a. Single phase and three phase;
   b. Fractional HP manual motor starters, magnetic motor starters, motors-DC, single phase and three phase;
   c. Push-button control, relays, contactors & magnetic starters, ladder diagram;
   d. Timing relays, counters;
   e. Pressure switches, float switches, limit switches, two wire control, three wire control multiple push-button stations;
   f. Jog control, hand-off automatic control, drum switch; and,
   g. Sequence control.

2. Student will demonstrate how to properly use:
   a. Single phase and three phase;
   b. Fractional HP manual motor starters, magnetic motor starters, motors-DC, single phase and three phase;
   c. Push-button control, relays, contactors & magnetic starters, ladder diagram;
   d. Timing relays, counters;
   e. Pressure switches, float switches, limit switches, two wire control, three wire control multiple push-button stations;
   f. Jog control, hand-off automatic control, drum switch; and,
   g. Sequence control.

3. Instructors will grade student's ability to properly use:
   a. Single phase and three phase;
   b. Fractional HP manual motor starters, magnetic motor starters, motors-DC, single phase and three phase;
   c. Push-button control, relays, contactors & magnetic starters, ladder diagram;
   d. Timing relays, counters;
   e. Pressure switches, float switches, limit switches, two wire control, three wire control multiple push-button stations;
   f. Jog control, hand-off automatic control, drum switch; and,
   g. Sequence control.

INT-E8-HO
Prepare and Update Specification Forms
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to:

a. Prepare specification forms; and,
b. Update specification forms.

Module Outline:

I. General
II. Specific Structure
III. Assembly
IV. Tests
V. Criteria

INT-E8-LW
Prepare and Update Specification Forms
Attachment 2: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to write a specification:
   a. General;
   b. Specific structure;
   c. Assembly;
   d. Tests; and,
   e. Criteria.

2. Student will demonstrate how to write a specification:
   a. General;
   b. Specific structure;
   c. Assembly;
   d. Tests; and,
   e. Criteria.

3. Instructor will grade student's ability to write a specification:
   a. General;
   b. Specific structure;
   c. Assembly;
   d. Tests; and,
   e. Criteria.

INT-E9-HO
Write Work Orders
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to write work orders.

Reading Assignments:

Handbook of Modern Manufacturing Management, Magnard, McGraw-Hill Publishers, Latest Edition:

Chapter	**Title**
102-125	Work Order

Also, refer to plant specific materials.

Module Outline:

I. Define Work Order
II. Major Section of Work Order
III. Proper Signatures
IV. Work Order Classification
V. Completion Anticipated Date
VI. Actual Completion Date
VII. Work Order vs. Maintenance Log
VIII. Work Order Statistics
IX. Prioritize
X. Plan and Schedule

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and re-pair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and re-pair transmit-ters	C-12 Test dif-ferent field sensing ele-ments, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Cali-brate trans-mitters	C-15 Tune controllers pneumatic and electronic	C-16 Trouble-shoot and re-pair plant com-puting systems relating to pro-cess controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and re-pair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and con figure smart field devices, i.e., transmit-ters and valves	C-35 Operate control systems including single element, cas-cade, ratio, and feedforward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Deter-mine proper tools, equip-ment, and ma terials to per-form the job	D-3 Coordi-nate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment iso-lation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibra-tion proce-dures	D-8 Follow specifications and proce-dures	D-9 Perform algebraic op-erations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibra-tion data	E-2 Record preventive maintenance data	E-3 Record equipment disconnect data	E-4 Evaluate collected data	E-5 Review/ revise proce-dures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Applica-tion of ISA/IEC standards	F-5 Under-stand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Under-stand personal computers	F-10 Attend on-going safety training courses	F-11 Partici-pate in plant related train-ing	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

INT-F1-HO
Read/Interpret Diagrams and Drawings
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Read single line diagrams;
b. Interpret single line diagrams;
c. Read schematic diagrams;
d. Interpret schematic diagrams;
e. Read wiring diagrams;
f. Interpret wiring diagrams;
g. Read ladder diagrams;
h. Interpret ladder diagrams;
i. Read process diagrams;
j. Interpret process diagrams;
k. Read logic diagrams; and,
l. Interpret logic diagrams.

Reading Assignments:

Instrumentation, Kirk, ATP Publishers, Latest Edition:

Chapter	Title
Appendix A	Instrumentation Symbols
Appendix B	Electrical Symbols

Module Outline:

I. Single Line Diagrams
II. Schematic Diagrams

III. Wiring Diagrams
IV. Ladder Diagrams
V. Process Diagrams
VI. Logic Diagrams

INT-F1-LA
Read/Interpret Diagrams and Drawings
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-F1-LW
Read/Interpret Diagrams and Drawings
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Read single line diagrams;
   b. Interpret single line diagrams;
   c. Read schematic diagrams;
   d. Interpret schematic diagrams;
   e. Read wiring diagrams;
   f. Interpret wiring diagrams;
   g. Read ladder diagrams;
   h. Interpret ladder diagrams;
   i. Read process diagrams;
   j. Interpret process diagrams;
   k. Read logic diagrams; and,
   l. Interpret logic diagrams.

2. Student will practice how to:
   a. Read single line diagrams;
   b. Interpret single line diagrams;
   c. Read schematic diagrams;
   d. Interpret schematic diagrams;
   e. Read wiring diagrams;
   f. Interpret wiring diagrams;
   g. Read ladder diagrams;
   h. Interpret ladder diagrams;
   i. Read process diagrams;
   j. Interpret process diagrams;
   k. Read logic diagrams; and,
   l. Interpret logic diagrams.

3. Instructor will grade the student's ability to:
   a. Read single line diagrams;
   b. Interpret single line diagrams;
   c. Read schematic diagrams;
   d. Interpret schematic diagrams;
   e. Read wiring diagrams;
   f. Interpret wiring diagrams;
   g. Read ladder diagrams;
   h. Interpret ladder diagrams;
   i. Read process diagrams;
   j. Interpret process diagrams;

k. Read logic diagrams; and,
l. Interpret logic diagrams.

INT-F2-HO
Sketch Diagrams
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Sketch single line diagrams;
b. Sketch schematic diagrams;
c. Sketch wiring diagrams;
d. Sketch ladder diagrams;
e. Sketch logic diagrams; and,
f. Sketch process diagrams.

Reading Assignments:

Instrumentation, Kirk, ATP Publishers, Latest Edition:

Chapter	**Title**
Appendix A	Instrumentation Symbols
Appendix B	Electrical Symbols

Module Outline:

I. Schematic Diagrams
II. Logic Diagrams
III. Ladder Diagrams
IV. Wiring Diagrams
V. Single Line Diagrams
VI. Process Diagrams

INT-F2-LA
Sketch Diagrams
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-F2-LW
Sketch Diagrams
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to sketch:
   a. Schematic diagrams;
   b. Logic diagrams;
   c. Ladder diagrams;
   d. Wiring diagrams;
   e. Single line diagrams; and,
   f. Process diagrams.

2. Student will practice how to sketch:
   a. Schematic diagrams;
   b. Logic diagrams;
   c. Ladder diagrams;
   d. Wiring diagrams;
   e. Single line diagrams; and,
   f. Process diagrams.

3. Instructor will grade student by the student's ability to sketch.
   a. Schematic diagrams;
   b. Logic diagrams;
   c. Ladder diagrams;
   d. Wiring diagrams;
   e. Single line diagrams; and,
   f. Process diagrams.

INT-F3-HO
Study Technical Equipment Information
Attachment 1: **MASTER** Handout

Objective(s):

Upon completion of this module the student will be able to demonstrate knowledge of technical equipment through study of technical equipment information.

Module Outline:

I. Introduction
II. General
III. Specific Dimensions
IV. Specific Tolerances
V. How to Use

INT-F4-HO
Application of ISA/JIC Standards
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the computer lab by not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Apply ISA standards to instrumentation; and,
b. Apply JIC standards to instrumentation.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

Chapter	Title
Appendix A	ISA Symbols

Module Outline:

I. Define ISA
II. Purpose of ISA
III. ISA Functions
IV. Define JIC
V. Purpose of JIC
VI. JIC Functions

Standards of performance safety:

Student shall demonstrate safe work habits in the computer lab by not participating in horse play or practical joking.

INT-F4-LW
Application of ISA/JIC Standards
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Access the Internet;
   b. Access ISA (www.isa.org);
   c. Explore functions of ISA through the Internet; and,
   d. Repeat procedure for JIC.

2. Student will demonstrate how to:
   a. Access the Internet;
   b. Access ISA (www.isa.org);
   c. Explore functions of ISA through the Internet; and,
   d. Repeat procedure for JIC.

3. Instructor will grade student's ability to:
   a. Access the Internet;
   b. Access ISA (www.isa.org);
   c. Explore functions of ISA through the Internet; and,
   d. Repeat procedure for JIC.

INT-F5-HO
Understand Proper Use of Test Equipment and Tools
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Demonstrate proper use of test equipment; and,
b. Demonstrate proper use of tools.

Reading Assignments:

Instrumentation, Kirk, ATS Publishers, Latest Edition:

The entire book

Module Outline:

I. Define Hand Tools
   A. Hammer
   B. Wrenches
   C. Pliers
   D. Screwdriver
   E. Socket
   F. Socket Wrench
   G. Wire Cutters
   H. Wire Strippers
II. Define Power Tools
   A. Drill
   B. Sanders
III. Define Test Equipment
   A. Scope

B. DMM
C. Pressure Source
D. Calibrator
E. Clamp on Ammeter
F. Insulation Tester

INT-F5-LA
Understand Proper Use of Test Equipment and Tools
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Demonstrate proper use of test equipment; and,
   c. Demonstrate proper use of tools.

INT-F5-LW
Understand Proper Use of Test Equipment and Tools
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate proper use of:
   a. Hand Tools;
      (1) Hammer;
      (2) Wrenches;
      (3) Pliers;
      (4) Screwdriver;
      (5) Socket;
      (6) Socket wrench;
      (7) Wire cutters;
      (8) Wire strippers;
   b. Power Tools;
      (1) Drill;
      (2) Sanders;
   c. Test Equipment;
      (1) Scope;
      (2) DMM;
      (3) Pressure source;
      (4) Calibrator;
      (5) Clamp on ammeter; and,
      (6) Insulation tester.

2. Student will demonstrate proper use of:
   a. Hand Tools;
      (1) Hammer;
      (2) Wrenches;
      (3) Pliers;
      (4) Screwdriver;
      (5) Socket;
      (6) Socket wrench;
      (7) Wire cutters;
      (8) Wire strippers;
   b. Power Tools;
      (1) Drill;
      (2) Sanders;
   c. Test Equipment;
      (1) Scope;
      (2) DMM;
      (3) Pressure source;
      (4) Calibrator;

(5) Clamp on ammeter; and,
(6) Insulation tester.

3. Instructor will grade student's ability to:
   a. Hand Tools;
      (1) Hammer;
      (2) Wrenches;
      (3) Pliers;
      (4) Screwdriver;
      (5) Socket;
      (6) Socket wrench;
      (7) Wire cutters;
      (8) Wire strippers;
   b. Power Tools;
      (1) Drill;
      (2) Sanders;
   c. Test Equipment;
      (1) Scope;
      (2) DMM;
      (3) Pressure source;
      (4) Calibrator;
      (5) Clamp on ammeter; and,
      (6) Insulation tester.

INT-F6-HO
Learn to Write Technical Reports
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Write technical reports;
b. Conduct research;
c. Develop technical report;
d. Prepare memo; and,
e. Present technical report.

Reading Assignments:

Technical Writing: A Practical Approach, William Pfeiffer, Prentice Hall, Latest Edition:

Chapter	Title
1	Process In Technical Writing
3	Organizing Information
9	Formal Reports
11	Graphics
13	Technical Research
15	Styles In Technical Writing

Module Outline:

I. Define Technical Report
II. Grammar/Composition Review
III. Language Usage-technical Communication
IV. Vocabulary

V. Idea Development
VI. Spelling
VII. Outlining
VIII. Sentence Elements
IX. Locating Information, Research Skills
X. Organizing Information
XI. Editing and Proofreading
XII. Construction of Reports
XIII. Graphic Use
XIV. Production of Technical Reports
XV. Presentation Skills

INT-F6-LW
Learn to Write Technical Reports
Attachment 2: **MASTER** Laboratory Worksheet

Guidelines for Instrumentation Notebook:

1. Use plain paper size 8 ½ x 11.
2. All lab report should be done on the computer. *Note:* Use any software programming that is available to you.
3. Only data gathered in the lab can be the same for the same group and the rest of lab report should be by each individual. Two exact lab reports I the same group will be graded zero.
4. Lab report must be complete, self-explanatory record of what you did, why you did it, what equipment was used for measurements, what each table of data represents, how the data was processed, what the results were, and any unexpected results that might warrant further investigation.
5. **Process**
   Collect data: chart, graphs
   Process data: calculations, measurement.
   Evaluate data: conclusions
   Assemble the data: write the report
6. **Conclusion**
   What did you do?
   Why did you do it?
   What results were obtained?
7. **Format**

Cover Sheet (see the example)	(5 pts)
Table of Contents	(7 pts)
Purpose or Introduction	(12 pts)
Equipment and Parts Used	(10 pts)
Circuit Diagram	(12 pts)
Calculations	(22 pts)
Charts and Graphs	(17 pts)
Conclusion	(10 pts)
References	(5 pts)
Total:	(100 pts)

Augusta Tech
Instrumentation Technology

Course No: _____

Instructor: _____

Date: _____

Lab Title: _____

Lab No.: _____

Submitted by: _____

Lab Partner: _____

Lab Partner: _____

Instructor Evaluation and Comments:

_____
_____
_____
_____
_____
_____

INT-F7-HO
Acquire Safe Practices for Handling Hydraulic and Special Tools
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Demonstrate safe handling of hydraulic tools; and,
b. Demonstrate safe handling of special tools.

Reading Assignments:

Industrial Hydraulics, Vickers, Latest Edition:

The entire book

Module Outline:

I. Hydraulic Theory
II. Storage Devices
III. Pumps-Prime Movers
IV. Actuators
V. Control Devices
VI. Accumulators

INT-F7-LA
Acquire Safe Practices for Handling Hydraulic and Special Tools
Attachment 2: **MASTER** Laboratory Aid

---

1. Instructor will:
   a. Insure proper procedures are used to safely construct physical project;
   b. Insure proper tools and materials are available for project completion;
   c. Insure proper techniques and safety procedures are followed in completing the project; and,
   d. Grade procedures and finished project.

2. Student will:
   a. Follow proper instructions and safety procedures to complete the project;
   b. Demonstrate the safe use of hydraulic tools; and,
   c. Demonstrate the safe use of the special tools.

INT-F7-LW
Acquire Safe Practices for Handling Hydraulic and Special Tools
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to use:
   a. Storage devices;
   b. Pumps-prime movers;
   c. Actuators;
   d. Control devices; and,
   e. Accumulators.

2. Student will demonstrate how to use:
   a. Storage devices;
   b. Pumps-prime movers;
   c. Actuators;
   d. Control devices; and,
   e. Accumulators.

3. Instructor will grade student's ability to use:
   a. Storage devices;
   b. Pumps-prime movers;
   c. Actuators;
   d. Control devices; and,
   e. Accumulators.

INT-F8-HO
Utilize Technical Manuals
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to utilize technical manuals.

Module Outline:

I. Define Technical Manual
II. Major Sections of Technical Manual
III. Sample Technical Manual

INT-F8-LW
Utilize Technical Manuals
Attachment 2: **MASTER** Laboratory Worksheet

---

1. Instructor will:
   a. Define technical manual;
   b. Describe major sections of technical manual; and,
   c. Show students sample technical manual.

2. Student will:
   a. Define technical manual;
   b. Describe major sections of technical manual; and
   c. Review sample technical manual.

INT-F9-HO
Understand Personal Computers
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the computer lab by not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. List major parts of computer;
b. Demonstrate a working knowledge of keyboard;
c. Demonstrate a working knowledge of DOS;
d. Demonstrate a working knowledge of Windows 3.1; and,
e. Demonstrate a working knowledge of Windows 95.

Reading Assignments:

Using Computers, A Gateway of Information, Shelley, Boyd & Fraser Publishing Company, Latest Edition:

Chapter	Title
1	Overview
2	Software
4	System Unit

Module Outline:

I. Major Parts of Digital and Analog Computer
II. Keyboard Skills
III. DOS
IV. Windows 3.1
V. Windows 95
VI. Word Processing Software
VII. Spreadsheet Software
VIII. Graphic Software
IX. Computer Languages

INT-F9-LW
Understand Personal Computers
Attachment 2: **MASTER** Laboratory Worksheet

---

1. Practice booting up a computer.
2. Practice properly powering down computer.
3. Practice using DOS commands.
4. Practice using Windows 3.1.
5. Practice using Windows 95.
6. Practice using a word processing software.
7. Practice using a spreadsheet software.
8. Practice using a graphic software.
9. Practice using a programming language.

INT-F10-HO
Attend On-Going Safety Training Courses
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify safety equipment appropriate to protect the eyes from flying particulate matter or chemicals;
b. Identify safety equipment appropriate to protect the head in an industrial, manufacturing or construction environment;
c. Identify equipment appropriate to protect against high level of noise;
d. Identify safety equipment appropriate to protect the hands while using solvents or working with sharp materials;
e. Identify safety equipment appropriate to protect the lungs from chemicals or particles;
f. Identify the two major factors in working safely;
g. List four steps you can take prior to performing work that will insure a safe outcome;
h. Identify the employees responsibility if a potential accident or unsafe condition exist;
i. Select specific task that have the potential to cause an injury;
j. Describe typical safety equipment used when working aloft;
k. Describe how to set up a portable ladder for use;
l. Define basic safety concerns while working from scaffolding;
m Identify the safety concerns to be addressed while working from a personal man basket;
n. Demonstrate use of a safety belt/harness;
o. Demonstrate proper set up and use of a portable ladder;
p. Identify the technicians responsibility relative to fire safety;
q. List condition required for fire to exist;
r. Name four classes of fires;

s. List four typical causes of industrial fires described in the lesson;
t. Match the correct class extinguishers to a given fuel source;
u. Demonstrate proper use of a fire extinguisher;
v. Identify the consequences of improper lifting techniques;
w. Recognize when it is unsafe to lift an object alone;
x. Demonstrate proper lifting techniques;
y. Identify safety concerns to be addressed when lifting rough, sharp or fragile items;
z. Recognize the benefits of an effective lockout/tagout procedure;
aa. Identify who is allowed to remove or install a lockout/tagout or lock;
ab. Recognize who is responsible for assuring equipment is properly locked out or tagged out prior to performing maintenance; and,
ac. Determine if all emergency conditions are cleared for maintenance.

Reading Assignments:

The following chapters are assigned to read from *Supervisor's Safety Manual* textbook, Latest Edition:

Chapter	Title
7	Controlling Hazards; Protecting the Eyes: Equipment Types, Face Protection, Overcoming Employee Complaints; Protecting the Head: Fabrication, Auxiliary Features, Overcoming Objections; Ear Protection: Amount of Protection, Insert-Type Protectors, Muff Types; Protecting Fingers, Palms, and Hands; Protecting the Torso; Respiratory Protective Equipment: Selecting the Respirator, Overcoming Employee Complaints; Safety Belts and Harnesses: Fabrication, Lifelines, Inspection and Care of Belts and Lines; Protection Against Ionizing Radiation: Monitoring Radiation; Safe Work Clothing: Materials for Protective Clothing; Clothing for Women, Special Problems Today for Men; "Selling" Personal Protective Equipment: Paying for Protective Equipment.
4	Promote Safe Workmanship: Employee Committees, Safety Posters, Special-Purpose Reminders, Off-Beat Ideas, Recognition Organizations, Safety Meetings; Off-the-Job Accident Problems: Cost of Off-the-Job Accident Problems: Cost of Off-the-Job Accidents, Humanitarian Reasons for OTJ Safety Activities, Measuring Accident Experience, Integrating OTJ with On-the-Job Safety Programs, the Supervisor's Role in OTJ Safety.

5	Giving Instructions: Importance of Job Instruction, Starting the New Man; On-the-Job Training: Over-the-Shoulder Coaching; Job Safety Analysis: Select the Job, Break the Job Down, Identify Hazards and Potential Accidents, Develop Solutions, Benefits of JSA; Job Instruction Training: Step 1-Preparations, Step 2-Presentation, Step 3-Application, Step 4-Testing Follow-up; Other Methods of Instruction: The Lesson Plan, Programmed Instruction, Independent Study, Closed-Circuit TV, Summary.
9	Material Handling Problems; Manual Handling Methods; Lifting and Carrying; Handling Specific Shapes; Equipment for Handling; Hand Trucks; Powered Hand Trucks; Powered Industrial Trucks; Conveyors; Chains and Slings
12	Basic Principles; Understanding Fire Chemistry; Determining Fire Hazards; Informing the Working Force; Causes of Fire: Electric Equipment, Friction; Special Fire-Hazard Materials; Welding and Cutting; Open Flames; Portable Heaters; Hot Surfaces; Smoking and Matches; Spontaneous Ignition; Static Electricity; Fire-Safe Housekeeping; Alarms; Equipment; Evacuation; Fire Alarms; What About Extinguishers?; Follow Up for Fire Safety; Fire Brigades; Special Fire Protection Problems

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Module Outline:

I. Describe Types of Conditions That Would Require the Use of Protective Equipment Due to Air Borne Partials
   - A. Grinding operations
   - B. Any time while in an active production environment
   - C. Near welding operations
   - D. Near high pressure water, air, or other medians i.e., oil
   - E. Possibility of splashing chemicals

II. Identify Condition That Would Require the Use of a Hard Hat
   - A. Generally anytime while in a construction or manufacturing environment
   - B. In areas with low overhead clearances

III. Review Conditions That Would Require Use of Hearing Protection
   - A. Ear plugs
   - B. Ear muffs
   - C. OSHA requirements

IV. Describe Typical Conditions That Would Warrant Use of Gloves to Protect the Hands
   - A. Grinding
   - B. Working with rough metals

C. Working with multi strand steal cables
D. Electrical (Special insulated gloves may be required for certain voltages)

V. Identify How Lungs Are Protected from Harmful Chemicals/Particles
A. Plant engineering/ventilation
B. Use of respirators or bubble suits
C. Review OSHA requirements for fiber glass, asbestos and chemical protection

VI. Major Factors in Working Safely
A. Knowing what records are required
1. Recognizing when things are not as they should be
B. Attitude towards safety
1. A state of mind that requires you to accept responsibility for you and your coworkers safety
2. A state of mind that does not compromise safety for production or speed
3. A state of mind that would stop production rather than put an employee at unnecessary risk

VII. Four Steps That Help Insure a Safe Job
A. Preparing to do the job
1. Research task to insure it can be performed
2. Appropriate tools and help are available
3. Proper lockout procedure
B. Select appropriate safety equipment
C. Once the job starts, maintain a clean work place
D. Avoid unsafe practices
1. Failing to use safety equipment
2. Performing task you are not qualified to perform
3. Rushing
4. Practical joking
5. Making do with a tool rather than getting the right tool

VIII. Employee Responsibility
A. Assure responsibility for your own safety
B. Notify crew and supervision of an unsafe condition occurs
C. Stop work if unsafe condition is identified

IX. Tasks That Have the Potential to Cause Injury
A. Working with electricity
B. Working near rotating equipment
C. Working with chemicals and solvents
D. Using pneumatic or hydraulic equipment
E. Using ladders
F. Lifting heavy objects
G. Working in areas with harmful fumes

X. Identify Safety Equipment Used When Working Aloft

Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA

A. Equipment common to most personnel when working aloft
   1. Safety glasses
   2. Hard hat
   3. Safety belt or harness

XI. Describe How to Set up a Portable Ladder for Use

A. Portable ladder are broken down in the CFRs as metal and wood ladders

B. Wood ladders see 29 CFR-1910.25
   1. Single section ladder
   2. Two section ladder
   3. Special use wood ladders
   4. Step ladder

C. Metal ladders see 29 CFR-1910.26

D. Set up 29 CFR-1910.26
   1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall for all sectional ladders

XII. Basic Safety Concerns While Working from Scaffolding

Note: This module does not address scaffolding erection because special training is required

A. Employees working from scaffolding are subject frequently to hazards such as hot pipes low overhead, possible sharp edges from tiewire

B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness

C. Never lean over the handrails to perform work

XIII. Concerns While Working from a Manlift or Personnel Fit (see 29 CFR-1910.68)

A. Use basket or lift for employees and tools only not freight

B. If basket has integral test weights insure weights are removed prior to lifting personnel

C. Hands must be inside basket while basket is moving

D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline

E. Always inspect basket rigging prior to entry

F. Once the basket is in position it must be tied off if egress from the basket is required

XIV. Demonstrate Proper Set up and Use of an Extension Ladder

A. Determine wall to base of ladder distance

B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder

XV. Technician's Responsibility

A. Each employer will have company specific rules

B. Unless the technician is part of the company fire fighting crew or fire brigade
   1. Notify every one in the area to evacuate
   2. Get to a phone and notify appropriate department
   3. Something as simple as an ash tray or trash can, can start fire that may be easily and safely extinguished. Appropriate department must be notified of the event
   4. Employees are responsible for keeping the workplace safe and for reporting unsafe conditions

XVI. Identify Conditions Required for a Fire to Exist
- A. Fuel
- B. Oxygen
- C. Heat

XVII. Four Classes of Fire
- A. Ordinary combustibles
- B. Flammable liquids
- C. Electrical
- D. Combustible metals

XVIII. List Four Typical Causes of Workplace Fires
- A. Careless smokers
- B. Electrical overloads
- C. Inadequate fire watch for welding and cutting operations
- D. Combustible dust in the atmosphere

XIX. Demonstrate How to Match the Correct Extinguishers for the Class of Fire

XX. Demonstrate Proper Use of a Fire Extinguisher

XXI. Discuss the Importance of Lifting Safely
- A. Give each student a copy of the following attachments
   1. Laboratory aid
   2. Objectives, reading assignments, and module outline
   3. Laboratory worksheet

XXII. Identify the Steps to Manually Lift Safely
- A. Estimate the load to be lifted. If it is heavier than one person should attempt, get help
- B. Place feet properly. Spread your feet slightly (comfortably), with one foot slightly ahead of the other and alongside the object
- C. Bend knees, kneel, or squat. Get close enough to the load to reach under it without bending the back
- D. Use blocking under objects to get a handhold and to prevent crushed fingers
- E. Get a good grip. Be sure you can maintain your grip on the object. Use gloves when handling sharp or rough objects
- F. Let the legs do the lifting. To rise, straighten your legs, letting the powerful leg, arm, and shoulder muscles do the lifting
- G. Do not turn the body at the waist while carrying a load

H. Lower the load to the floor from the carrying position by bending the knees while keeping the back straight. This keeps the load on the leg and arm muscles. Keep fingers and toes clear as the load is set

XXIII. Discuss Equipment for Material Handling

A. Hand Trucks
B. Powered Trucks
C. Conveyers

XXIV. Discuss and Demonstrate Safe Use of Hand Trucks

A. Place most of the weight on bed of hand truck
B. May require two people id object is difficult to lift on our side
C. Hold object tightly as handled is pulled back
D. Adjust handle position so more weight is on hand end
E. After movement; hold object tightly as handle is moved upward
F. Lift object on one side so bed of truck can be moved away from object

XXV. Discuss and Demonstrate Use of Powered Hand Trucks

A. Watch out for people
B. Use caution drive unit slowly
C. Use manual lifting rules

XXVI. Discuss and Demonstrate Safe Use of Conveyers

A. Watch for pinch points
B. Exercise caution when loading and unloading objects
C. Do not overload conveyers. Rollers may not move freely

XXVII. Discuss and Demonstrate Safe Use of Chains and Slings

A. Storage area should be clean and dry
B. Watch for pinch points
C. Inspect for defects before using:
    1. Chains
        a. Wear
        b. Stretch
        c. Distortion
        d. Nicks
        e. Cracks
        f. Gauges
    2. Slings
        a. Wear
        b. Stretch
        c. Distortion
        d. Flat, Sling Spots
D. Types
    1. Slings
        a. Choker
        b. Double Choker
        c. Bridle

d. Basket
e. Double Basket

XXVIII. Benefits of an Effective Lockout/Tagout Program
- A. Reduce employee injuries and death
- B. Reduce down time
- C. Increased awareness of employees role in insuring safety in the work environment
- D. Less regulatory involvement
- E. Review 29 CFR-1910.147

XXIX. Who May Hang, Remove a Lockout or Tagout Tag or Lock
- A. Identify when a lockout is needed
- B. Identify when a tagout is appropriate. This will vary between industry clearance procedures

XXX. Responsibility for Lockout/Tagout
- A. Typically it is the work crew leader
  1. He/she is also responsible for briefing the crew as to the clearance boundaries and what is locked out
- B. Carefully loosen a flange and break the seal (Never remove the bolts). Only loosen slightly
- C. Open system relief valve

XXXI. Locking out or Clearing a Piping, Mechanical System or Component for Maintenance
- A. Identify typical sources of force that may be present in a typical piping system
  1. Static head pressure/thermal induced pressure
  2. Incline accumulators
  3. Unisolated automatic actuating valves, motors or relief
  4. System pressure
  5. Stress that any or all of these forces have the ability to injure or kill is not properly cleared lockout and depressurized prior to maintenance
- B. Methods of relieving trapped pressure from a system or component
  1. Vent and drain valves
  2. Carefully loosen a flange and break the seal (*never* remove the bolts); only loosen slightly
  3. Open system relief valve
- C. Identify typical methods of disabling components prior to maintenance
  1. Manual operated valves
  2. Pneumatic operated valves (fail open or closed)
  3. Hydraulic actuated valve
  4. Relief valves
  5. Fans
  6. Rollers

D. Energy sources can take many forms, including:
   1. Electrical
   2. Pneumatic
   3. Hydraulic
   4. Mechanical
   5. Fluid and gases
   6. Thermal
   7. Water under pressure
   8. Gravity

E. Accidental start-up and/or release of stored energy can sometimes be controlled with safety devices. Some examples are:
   1. Machine guards
   2. Electrical disconnects
   3. Mechanical stops
   4. Point-of-operation guards

XXXII. Electric Shock
   A. Voltage Level
   B. Current Level
   C. One Hand Rule

XXXIII. Electrical Resistance
   A. Body Resistance
   B. Current Path
   C. Ohm's Low

XXXIV. Electrical Test Meters
   A. Ohmmeter
   B. Voltmeter
   C. Ammeter

XXXV. Tools
   A. Ladders
   B. Electrical Hand Tools
   C. Tool Condition

XXXVI. Protective Equipment
   A. Multimeter
   B. Electrical Gloves
   C. Electrical Hand Tools

XXXVII. Ground Fault Circuit Interrupter (GFCI)
   A. NEC Requirements
   B. How GFCI Works
   C. GFCI Format

XXXVIII. Two Man Rule
   A. Buddy System
   B. Second Person's Responsibility

XXXIV. Guarding
   A. Safe distance from live circuits

B. NEC 110-10, 240-41, 430-14, 511-7, 513-5, 514-4, 515-4, 516-7, 517

C. 29 CFR 1910.331 through 29 CFR 1910.335

Standards of performance safety:

Student shall demonstrate safety knowledge when working in the shop by:
Observing all safety rules in lab;
Not touching an energized electrical circuit;
Exercising extreme caution in dealing with an electrical circuit;
Using electrically tested gloves and properly using calibrated test equipment when working with electricity;
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-F10-LW
Attend On-Going Safety Training Courses
Attachment 3: **MASTER** Laboratory Worksheet

Worksheet:

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Ear Plugs
   Ear Muffs

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercise inserting and removing ear plugs.

5. Practice using ear plugs.

6. Practice exercise using ear muffs.

Worksheet:

I. Identify safety equipment used when working aloft.

Note: Each industry has its own safety manual with rules for working aloft and they may be more stringent than OSHA.

A. Equipment common to most personnel when working aloft:
   1. Safety glasses
   2. Hard hat
   3. Safety belt or harness

2. Describe how to set up a portable ladder for use.

A. Portable ladders are broken down in the CFRs as metal and wood ladders.

B. Wood ladders (see 29 CFR-1910.25)
   1. Single section ladder
   2. Two section ladder
   3. Special use wood ladders
   4. Step ladder

C. Metal ladders (see 29 CFR-1910.26)

D. Set up 29 CFR-1910.26
   1. Simple rule is to set the base a length of 1/4 the working length from the vertical wall.

3. Basic safety concerns while working from scaffolding.

Note: This module does not address scaffolding erection because special training is required.

A. Employees working from scaffolding are subject frequently to hazards such as hot pipes, low overhead, possible sharp edges from tiewire.

B. Typical safety equipment would be hard hat, safety glasses, gloves, safety belt or harness.

C. Never lean over the handrails to perform work.

4. Concerns while working from a manbasket or personnel fit.

A. Use basket or lift for employees and tools only not freight

B. If basket has integral test weights insure weights are removed prior to lifting personnel.

C. Hands must be inside basket while basket is moving.

D. Safety belts or harness must be worn and properly affixed to number designed for securing lifeline.

E. Always inspect basket rigging prior to entry.

F. Once the basket is in position it must be tied off if egress from the basket is required.

5. Demonstrate proper set up and use of an extension ladder.
   A. Determine wall to base of ladder distance.
   B. Demonstrate how to tie off the ladder and how to use a safety belt when performing work from a ladder.

Worksheet:

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Hand truck
   Conveyor
   Chains
   Sling
   Face shield
   Side shields

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercise manual lifting.

5. Practice using hand truck to carry objects.

6. Practice using powered truck to carry objects.

7. Practice exercise handling specific shapes.

8. Practice lifting with slings.

9. Practice lifting with chains.

10. Instructor will guide each exercise.

11. Instructor will grade each exercise.

Worksheet:

The project will require the student to demonstrate skills and knowledge in the following.

a. Practice safety
b. Use approved eye protection.
c. Remove energy source
d. Place tag
e. Place lock
f. Sign tag
g. Remove lock
h. Remove tag

1. Established standards for safety and conduct shall be followed.

2. Equipment required:
   Lock
   Tag
   Safety Switch

3. Exercises must be taken in sequence. Instructor must confirm proficiency prior to student progressing to next exercise.

4. Practice exercises:
   A. Use lock to lock energy supply.
      (Instructor must demonstrate placing lock on energy supply.)
   B. Use tag to tag energy supply.
      (Instructor must demonstrate placing tag on energy supply.)

5. Practice exercise :
   1. Student shall practice placing tag on energy source.
   2. Student shall practice placing lock on energy source.

INT-F11-HO
Participate in Plant Related Training
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Discuss why plant related training is important;
b. Compare team to group;
c. Define PPE; and,
d. Define SPC.

Module Outline:

I. Safety
II. Produce Familiarity
III. Team Building
IV. Quality
V. Plant Related Training

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-F12-HO
Attend PLC Training
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify major components of PLCs;
b. Program PLCs;
   1. Examine ON;
   2. Examine OFF;
   3. Output energize;
   4. Timers;
   5. Counter;
   6. Output latch;
   7. Master control relay;
   8. SFCs;
   9. Modes; and,
   10. PID.

Reading Assignments:

Programmable Controllers And Design, Sequential Logic, Files, HBJ Publishing, Latest Edition:

Chapter	Title
1	Sequential Control
3	Relay Logic
4	Digital Logic
6	Programmable Controllers
7	Devices Used In Relay Logic
8	Processor Memory

9	Ladder Logic
10	Timer and Counter Instructions
14	Program Control Instructions
17	PLC Programming Languages

Module Outline:

I. Major Parts of PLC
II. Number Systems
III. Logic
IV. Inputs, Outputs
V. Timers
VI. Counter
VII. Master Control Relays
VIII. SFCs
IX. Modes
X. PID

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-F12-LW
Attend PLC Training
Attachment 3: **MASTER** Laboratory Worksheet

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1. Students will practice Programming a PLC:
    1. Major Parts of PLC;
    2. Number Systems;
    3. Logic;
    4. Inputs, Outputs;
    5. Timers;
    6. Counter;
    7. Master Control Relays;
    8. SFCs;
    9. Modes; and,
    10. PID.

2. Instructor will grade practical exercises.

INT-F13-HO
Attend DCS Training
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Operate DCS Network;
b. Maintain DCS Network; and,
c. Troubleshoot DCS Network.

Module Outline:

I. Physical Topology
II. Electrical Topology
III. Connecting Methodologies
IV. LAN
V. WAN

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-F13-LW
Attend DCS Training
Attachment 3: **MASTER** Laboratory Worksheet

PROVOX/PLC PRACTICAL EXERCISE PROVOX		
NAME:		
SSN:		
Instructor Hits <P1>, <E>, & Lime Unloading is displayed		
	YES	NO
Have you used PROVOX before?		
Start 5M103 Conveyor to South Silo - In Reverse (<DSR> <3> <E> <SK >)		
Tell DSR3		
Stop 5M103 Conveyor to Lime Silo (<DSR> <3> <E>- <SK1>)		
Start Lime Unloading Sequence using 5HS-S1 (<DSR> <7> <E> - <SK2>)		
Change Lime Unloading Sequence to OFF by turning OFF 5HS-S1 (<DSR> <7> <E> <SKI>)		
Go to Display 13 (<SHOW DISPLAY #> <13> <E>)		
Show detail display parameters for 5LIC126-3 Hot Water Tank (<DSR> <2> <E> <SHOW DETAIL #> <E>)		
For 5LIC126-3, What is the Gain = 10.0		
For 5LIC126-3, What is the Reset = 0.100		
For 5LIC126-3, What is the Rate = 0.000		
Given ALM C TR is configured for a high alarm, what is the trip point? 100.00		
Given ALM C TR is configured for a high alarm, what is the deadband? 4.00		
Go back to last display (<SHOW LAST DISPLAY>) - should be display 13		
Go to Point Directory Display (<CTRL POINT #> or < DIR> <SK1>)		
Find 6M852 in Point Directory (use <PAGE FWD> to display)		
Pick DSR "0" in bottom field and show Detail On Point (<CTRL POINT #> <182> <E>)		
Return to Display 10 (SHOW DISPLAY#> <10> >E>)		
What is the range of analog input point accessed by DSR 15? (<DSR> <15> <E> <SHOW DETAIL #> <E>) 0-100		
Return to Display 10 (<SHOW DISPLAY #> <10> <E>) or (<SHOW LAST DISPLAY>)		

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working aloft	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Troubleshoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure software	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Troubleshoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Troubleshoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Troubleshoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Troubleshoot and repair recorders	C-10 Troubleshoot linear variable differential transformers	C-11 Troubleshoot and repair transmitters	C-12 Test different field sensing elements, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Calibrate transmitters	C-15 Tune controllers pneumatic and electronic	C-16 Troubleshoot and repair plant computing system relating to process controls	C-17 Troubleshoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Troubleshoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Troubleshoot and repair local controllers	C-26 Troubleshoot and repair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate ox analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and configure smart field devices, i.e. transmitters and valves	C-35 Operate control systems including single element, cascade, ratio, and feedforward	C-36 Troubleshoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Determine proper tools, equipment, and materials to perform the job	D-3 Coordinate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment up for prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibration procedures	D-8 Follow specifications and procedures	D-9 Perform algebraic operations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibration data	E-2 Record preventive maintenance data	E-3 Record equipment downtime data	E-4 Evaluate collected data	E-5 Review/ revise procedures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Application of ISA/IEC standards	F-5 Understand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Understand personal computers	F-10 Attend on-going safety training courses	F-11 Participate in plant related training	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Troubleshoot, install, maintain, and operate motor starters	H-2 Troubleshoot, install, maintain, and operate relays	H-3 Troubleshoot, install, maintain, and operate pushbuttons	H-4 Troubleshoot, install, maintain and operate switches	H-5 Troubleshoot, install, maintain and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Troubleshoot, install, maintain and operate PLCs					

INT-G1-HO
Learn to Review and Forecast Spare Parts Inventory
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Review spare parts inventory; and,
b. Forecast spare parts inventory.

Module Outline:

I. Parts Nomenclature
II. Parts Familiarity
III. Vendor Name or Number
IV. Software Familiarity
V. Forecasting Characteristics

INT-G1-LW
Learn to Review and Forecast Spare Parts Inventory
Attachment 2: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Review spare parts inventory;
   b. Make list of parts common characteristics;
   c. Identify common vendors; and,
   d. Use software to forecast inventory needs.

2. Student will demonstrate how to:
   a. Review spare parts inventory;
   b. Make list of parts common characteristics;
   c. Identify common vendors; and,
   d. Use software to forecast inventory needs.

3. Instructor will grade student's ability to:
   a. Review spare parts inventory;
   b. Make list of parts common characteristics;
   c. Identify common vendors; and,
   d. Use software to forecast inventory needs.

INT-G2-HO
Prepare Parts Request
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Prepare parts request;
b. Explain functions of major equipment;
c. Pick out parts from exploded view;
d. Pick out parts from assembly view;
e. Pick out parts from composite view; and,
f. Research back order.

Module Outline:

I. Exploded View
II. Composite View
III. Assembly View
IV. Pictorial View
V. Parts List

INT-G2-LW
Prepare Parts Request
Attachment 2: **MASTER** Laboratory Worksheet

---

1. Instructor will:
   a. Draw example of exploded view;
   b. Draw example of assembly view; and,
   c. Draw example of composite view.

2. Student will:
   a. Draw example of exploded view;
   b. Draw example of assembly view; and,
   c. Draw example of composite view.

3. Instructor will grade student's ability to:
   a. Draw example of exploded view;
   b. Draw example of assembly view; and,
   c. Draw example of composite view.

INT-G3-HO
Verify Parts Received
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Verify parts received;
b. Use packing list to verify parts received; and,
c. Distinguish between ordered and shipped parts.

Module Outline:

I. Parts Familiarity
II. Packing List
III. Packing List Components
IV. Back Order Procedures
V. Tracking Procedure

INT-G3-HO
Verify Parts Received
Attachment 2: **MASTER** Laboratory Worksheet

---

1. Instructor will demonstrate how to:
   a. Verify parts received;
   b. Use packing list to verify parts received; and,
   c. Distinguish between ordered and shipped parts.

2. Student will demonstrate how to:
   a. Verify parts received;
   b. Use packing list to verify parts received; and,
   c. Distinguish between ordered and shipped parts.

3. Instructor will grade student's ability to:
   a. Verify parts received;
   b. Use packing list to verify parts received; and,
   c. Distinguish between ordered and shipped parts.

INT-G4-HO
Research/Verify Substitute Specifications
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Substitute parts for parts that do not match exact characteristics;
b. Research substitute specifications; and,
c. Verify substitute specifications.

Module Outline:

I. Flexible Part Characteristics
II. Non-Flexible Part Characteristics
III. Substitute Parameters

INT-G4-LW
Research/Verify Substitute Specifications
Attachment 2: **MASTER** Laboratory Worksheet

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1. Instructor will demonstrate how to:
   a. Substitute parts for parts that do not match exact characteristics;
   b. Research substitute specifications; and,
   c. Verify substitute specifications.

2. Student will demonstrate how to:
   a. Substitute parts for parts that do not match exact characteristics;
   b. Research substitute specifications; and,
   c. Verify substitute specifications.

3. Instructor will grade student's ability to:
   a. Substitute parts for parts that do not match exact characteristics;
   b. Research substitute specifications; and,
   c. Verify substitute specifications.

INSTRUMENTATION AND CONTROL TECHNICIAN ... troubleshoots, repairs, calibrates, specifies, and commissions as required all instrumentation and control components relating to plant operations, including dynamic evaluation, testing, controller tuning, and total system performance evaluations.

Duties	Tasks												
A Practice Safety	A-1 Use protective equipment	A-2 Accident prevention	A-3 Working shift	A-4 Fire safety	A-5 Lifting safety	A-6 Lockout/ tagout	A-7 Use electrical equipment						
B Maintain Control Systems	B-1 Proper storage of circuit boards	B-2 Collect and record data according to company requirements	B-3 Test and calibrate transducers according to specs	B-4 Perform preventive maintenance procedures for control devices	B-5 Test and/ or replace printed circuit boards	B-6 Function check individual elements within loop	B-7 Trouble-shoot different types of system modules	B-8 Test different types of systems modules	B-9 Configure soft ware	B-10 Repair different types of system modules	B-11 Install control system hardware	B-12 Simulate control system check	B-13 Loop check control system
	B-14 Perform on-line testing												
C Maintain Field Instrumentation Devices	C-1 Test and calibrate pressure, level, flow, and temperature switches	C-2 Trouble-shoot and repair pressure, level, flow, and temperature switches	C-3 Adjust dampers and positioners	C-4 Trouble-shoot control drive (damper)	C-5 Test and calibrate indicators and gauges	C-6 Trouble-shoot and repair indicators	C-7 Test transmitters	C-8 Test and calibrate recorders	C-9 Trouble-shoot and repair recorders	C-10 Trouble-shoot linear variable differential transformers	C-11 Trouble-shoot and repair transmitters	C-12 Test different field sensing elements, flow, temperature, pressure, and level	C-13 Install/ replace field sensing elements
	C-14 Calibrate transmitters	C-15 Tune controllers pneumatic and electronic	C-16 Trouble-shoot and repair plant computing systems relating to process controls	C-17 Trouble-shoot and replace solenoid valves	C-18 Perform preventive maintenance procedures for field devices	C-19 Test and replace thermocouples	C-20 Check and test vibration sensing elements	C-21 Inspect and troubleshoot power supplies and converters	C-22 Test and calibrate control valve actuators	C-23 Trouble-shoot and repair control valves and positioners	C-24 Test and calibrate controllers	C-25 Trouble-shoot and repair local controllers	C-26 Trouble-shoot and repair electronic computing relays
	C-27 Test and calibrate gas analyzers	C-28 Test and calibrate air analyzers	C-29 Test and calibrate water analyzers	C-30 Trouble-shoot servo valves	C-31 Calibrate servo valves	C-32 Test and clean video display unit	C-33 Check and adjust video display unit	C-34 Design, specify and configure smart field devices, i.e., transmitters and valves	C-35 Operate control systems including single element, cascade, ratio, and feedforward	C-36 Trouble-shoot and repair analyzers			
D Organize Work Routines	D-1 Organize documents and drawings required on the job	D-2 Determine proper tools, equipment, and materials to perform the job	D-3 Coordinate work activities with other crafts or units	D-4 Coordinate preventive maintenance schedule with planning group	D-5 Verify equipment isolation prior to performance of work for safety reasons	D-6 Report abnormal equipment problems to supervisor	D-7 Write new calibration procedures	D-8 Follow specifications and procedures	D-9 Perform digitronic operations	D-10 Perform basic trigonometric functions	D-11 Perform basic calculus operations		
E Collect and File Data	E-1 Record test/calibration data	E-2 Record preventive maintenance data	E-3 Record equipment discrepancy data	E-4 Evaluate collected data	E-5 Review/ revise procedures	E-6 Write reports required by company	E-7 Specify equipment for control systems	E-8 Prepare and update specifications	E-9 Write work orders				
F Participate in Continuing Education Activities	F-1 Read/ interpret diagrams and drawings	F-2 Sketch diagrams	F-3 Study technical equipment information	F-4 Application of ISA/IEC standards	F-5 Understand proper use of test equipment and tools	F-6 Learn to write technical reports	F-7 Acquire safe practices for handling hydraulic and special tools	F-8 Utilize technical manuals	F-9 Understand personal computers	F-10 Attend on-going safety training courses	F-11 Participate in plant related training	F-12 Attend PLC training	F-13 Attend DCS training
G Maintain and Control Inventory	G-1 Learn to review and forecast spare parts inventory	G-2 Prepare parts request	G-3 Verify parts received	G-4 Research/ verify substitute specifications									
H Troubleshoot, Install, Maintain, & Operate Motor Control Systems	H-1 Trouble-shoot, install, maintain, and operate motor starters	H-2 Trouble-shoot, install, maintain, and operate relays	H-3 Trouble-shoot, install, maintain, and operate pushbuttons	H-4 Trouble-shoot, install, maintain, and operate switches	H-5 Trouble-shoot, install, maintain, and operate DCS networks	H-6 Prepare and update ladder and/or logic diagrams	H-7 Program PLCs	H-8 Trouble-shoot, install, maintain and operate PLCs					

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1415

DUTY H

INT-H1-HO
Troubleshoot, Install, Maintain, and Operate Motor Starters
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Operate motor starters;
b. Install motor starters;
c. Maintain motor starters; and,
d. Troubleshoot motor starters.

Reading Assignments:

Electronic Motor Control, Delmar Publishers, Latest Edition"

Chapter	Title
23	Primer Resistance Starters
24	Autotransformer Starters
25	Part Winding Starters
26	Delta Starters
27	Two Speed Starters

Module Outline:

I. Contactor
II. Motor Overloads
III. Full Line Motor Starters
IV. Primary Resistance Starters
V. Autotransformer Starters
VI. Part Winding Starters

VII. Star Delta Starters
VIII. Two Speed Starters
IX. Troubleshooting Motor Starters

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INT-H1-LA
Troubleshoot, Install, Maintain, and Operate Motor Starters
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Practice:

a. Contactor;
b. Motor overloads;
c. Full line motor starters;
d. Primary resistance starters;
e. Autotransformer starters;
f. Part winding starters;
g. Stat delta starters; and,
h. Two speed starters.

INT-H2-HO
Troubleshoot, Install, Maintain, and Operate Relays
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Operate relays;
b. Maintain relays;
c. Troubleshoot relays; and,
d. Install relays.

Reading Assignments:

Electronic Motor Control, Delmar Publishers, Latest Edition:

Chapter	Title
5	Relays and Contractors
6	Timing Relays
11	Phase Failure Relays
22	Time Delay, Low Voltage Release Relay

Module Outline:

I. Control Relay
II. Electrical Timing Relay
III. Pneumatic Timing Relay
IV. Electronic Timing Relay
V. Solid State Relay
VI. Phase Failure Relay
VII. Time Delay, Low Voltage Release Relay

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-H2-LW
Troubleshoot, Install, Maintain, and Operate Relays
Attachment 3: **MASTER** Laboratory Worksheet

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1. Practice identifying:
   a. Control relay;
   b. Pneumatic timing relay;
   c. Electrical timing relay;
   d. Electronic timing relay;
   e. Solid state relay;
   f. Phase failure relay; and,
   g. Time delay, low voltage release relay.

2. Practice installing:
   a. Control relay;
   b. Pneumatic timing relay;
   c. Electrical timing relay;
   d. Electronic timing relay;
   e. Solid state relay;
   f. Phase failure relay; and,
   g. Time delay, low voltage release relay.

3. Practice maintaining:
   a. Control relay;
   b. Pneumatic timing relay;
   c. Electrical timing relay;
   d. Electronic timing relay;
   e. Solid state relay;
   f. Phase failure relay; and,
   g. Time delay, low voltage release relay.

4. Practice troubleshooting:
   a. Control relay;
   b. Pneumatic timing relay;
   c. Electrical timing relay;
   d. Electronic timing relay;
   e. Solid state relay;
   f. Phase failure relay; and,
   g. Time delay, low voltage release relay.

INT-H3-HO
Troubleshoot, Install, Maintain, and Operate Pushbuttons
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Operate pushbuttons;
b. Install pushbuttons;
c. Maintain pushbuttons; and,
d. Troubleshoot pushbuttons.

Reading Assignments:

Electrical Motor Control, Delmar Publishers, Latest Edition

Chapter	Title
4	Pushbutton Control

Module Outline:

I. Pushbutton Familiarity
II. Pushbutton Operation
III. Pushbutton Installation
IV. Pushbutton Maintenance
V. Pushbutton Troubleshooting

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-H3-LW
Troubleshoot, Install, Maintain, and Operate Pushbuttons
Attachment 3: **MASTER** Laboratory Worksheet

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1. Answer questions assigned by instructor from textbook.

2. Practice installing push buttons in housing.

3. Practice ID pushbuttons:
   - A. Standard vs. heavy duty
   - B. Green P.B.
   - C. Red P.B.
   - D. Mushroom head P.B.
   - E. Selector switch
     1. 2 position
     2. 3 position
   - F. Selector switch
     1. NO
     2. NC
     3. NO-NC

4. Practice installing contact block to head

5. Practice troubleshooting a bad pushbutton.

INT-H4-HO
Troubleshoot, Install, Maintain, and Operate Switches
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Operate switches;
b. Maintain switches;
c. Troubleshoot switches; and,
d. Install switches.

Reading Assignments:

Electric Motor Control, Delmar Publishers, Latest Edition:

Chapter	Title
4	Pushbutton
8	Float Switches
9	Flow Switches
10	Limit Switches
13	Temperature Switches

Module Outline:

I. Toggle Switch
II. Limit Switch
III. Selector Switch
IV. Thermal Switch

V. Pressure Switch
VI. Photoelectric Switch
VII. Proximity Switch
VIII. Drum Switch

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-H4-LW
Troubleshoot, Install, Maintain, and Operate Switches
Attachment 3: **MASTER** Laboratory Worksheet

Practice:

1. Operating switches;
2. Maintaining switches;
3. Troubleshooting switches; and,
4. Installing switches.

INT-H5-HO
Troubleshoot, Install, Maintain, and Operate DCS Networks
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:
a. Operate DCS network;
b. Maintain DCS network; and,
c. Troubleshoot DCS network.

Module Outline:

I. Physical Topology
II. Electrical Topology
III. Connecting Methodologies
IV. LAN
V. WAN

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-H5-LW
Troubleshoot, Install, Maintain, and Operate DCS Networks
Attachment 3: **MASTER** Laboratory Worksheet

PROVOX/PLC PRACTICAL EXERCISE PROVOX		
NAME:		
SSN:		
Instructor Hits <P1>, <E>, & Lime Unloading is displayed		
	YES	NO
Have you used PROVOX before?		
Start 5M103 Conveyor to South Silo - In Reverse (<DSR> <3> <E> <SK >)		
Tell DSR3		
Stop 5M103 Conveyor to Lime Silo (<DSR> <3> <E>- <SK1>)		
Start Lime Unloading Sequence using 5HS-S1 (<DSR> <7> <E> - <SK2>)		
Change Lime Unloading Sequence to OFF by turning OFF 5HS-S1 (<DSR> <7> <E> <SKI>)		
Go to Display 13 (<SHOW DISPLAY #> <13> <E>)		
Show detail display parameters for 5LIC126-3 Hot Water Tank (<DSR> <2> <E> <SHOW DETAIL #> <E>)		
For 5LIC126-3, What is the Gain = 10.0		
For 5LIC126-3, What is the Reset = 0.100		
For 5LIC126-3, What is the Rate = 0.000		
Given ALM C TR is configured for a high alarm, what is the trip point? 100.00		
Given ALM C TR is configured for a high alarm, what is the deadband? 4.00		
Go back to last display (<SHOW LAST DISPLAY>) - should be display 13		
Go to Point Directory Display (<CTRL POINT #> or < DIR> <SK1>)		
Find 6M852 in Point Directory (use <PAGE FWD> to display)		
Pick DSR "0" in bottom field and show Detail On Point (<CTRL POINT #> <182> <E>)		
Return to Display 10 (SHOW DISPLAY#> <10> >E>)		
What is the range of analog input point accessed by DSR 15? (<DSR> <15> <E> <SHOW DETAIL #> <E>) 0-100		
Return to Display 10 (<SHOW DISPLAY #> <10> <E>) or (<SHOW LAST DISPLAY>)		

INT-H6-HO
Prepare and Update Ladder And/or Logic Diagrams
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Prepare ladder diagrams;
b. Update ladder diagrams;
c. Prepare logic diagrams; and,
d. Update logic diagrams.

Reading Assignments:

Electric Motor Control, Delmar Publishers, Latest Edition:

Chapter	Title
14	Symbols
15	Interpretation and Application of Wiring and Elementary Diagrams
21	Sequence Control

Module Outline:

I. Symbols
II. Wiring Diagrams
III. Ladder Diagrams
IV. Logic Diagrams

INT-H6-LA
Prepare and Update Ladder And/or Logic Diagrams
Attachment 2: **MASTER** Laboratory Aid

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-H6-LW
Prepare and Update Ladder And/or Logic Diagrams
Attachment 3: **MASTER** Laboratory Worksheet

Practice Wiring:

1. Symbols;
2. Wiring diagrams;
3. Ladder diagrams; and,
4. Logic diagrams.

INT-H7-HO
Program PLCs
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Identify major components of PLCs;
b. Program PLCs;
   1. Examine ON;
   2. Examine OFF;
   3. Output energize;
   4. Timers;
   5. Counter;
   6. Output latch;
   7. Master control relay;
   8. SFLs;
   9. Modes; and,
   10. PID.

Reading Assignments:

Programmable Controllers And Design, Sequential Logic, Files, HBJ Publishing, Latest Edition:

Chapter	Title
1	Sequential Control
3	Relay Logic
4	Digital Logic
6	Programmable Controllers
7	Devices Used In Relay Logic
8	Processor Memory

9	Ladder Logic
10	Timer and Counter Instructions
14	Program Control Instructions
17	PLC Programming Languages

Module Outline:

I. Major Parts of PLC
II. Number Systems
III. Logic
IV. Inputs, Outputs
V. Timers
VI. Counter
VII. Master Control Relays
VIII. SFCs
IX. Modes
X. PID

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-H7-LW
Program PLCs
Attachment 3: **MASTER** Laboratory Worksheet

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1. Student will practice programming a PLC:
   a. Major parts of PLC;
   b. Number systems;
   c. Logic;
   d. Inputs, outputs;
   e. Timers;
   f. Counter;
   g. Master control relays;
   h. SFCs;
   i. Modes; and,
   j. PID.

2. Instructor will grade practical exercises.

INT-H8-HO
Troubleshoot, Install, Maintain and Operate PLCs
Attachment 1: **MASTER** Handout

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

Objective(s):

Upon completion of this module the student will be able to:

a. Operate PLC;
b. Maintain PLC; and,
c. Troubleshoot PLC.

Reading Assignments:

Programmable Controllers and Designing Sequential, Files, HBJ Publishing, Latest Edition:

Chapter	Title
5	Safety Grouting, Troubleshooting, Maintaining
18	Select A PLC

Module Outline:

I. Major Parts of PLC
II. PLC Operation
III. PLC Modes
IV. PLC Maintenance
V. PLC Troubleshooting

Standards of performance safety:

Student shall demonstrate safe work habits in the shop by:
Using OSHA required safety equipment for the shop;
Safety glasses;
Hearing protection;
Face shields;
Gloves;
Not wearing rings, watches, jewelry, or loose clothing while operating equipment; and,
Not participating in horse play or practical joking.

INT-H8-LW
Troubleshoot, Install, Maintain and Operate PLCs
Attachment 3: **MASTER** Laboratory Worksheet

---

1. Student will practice:
   a. Operating PLC;
   b. Maintaining PLC; and,
   c. Troubleshooting PLC.

2. Instructor will grade based on student's performance.